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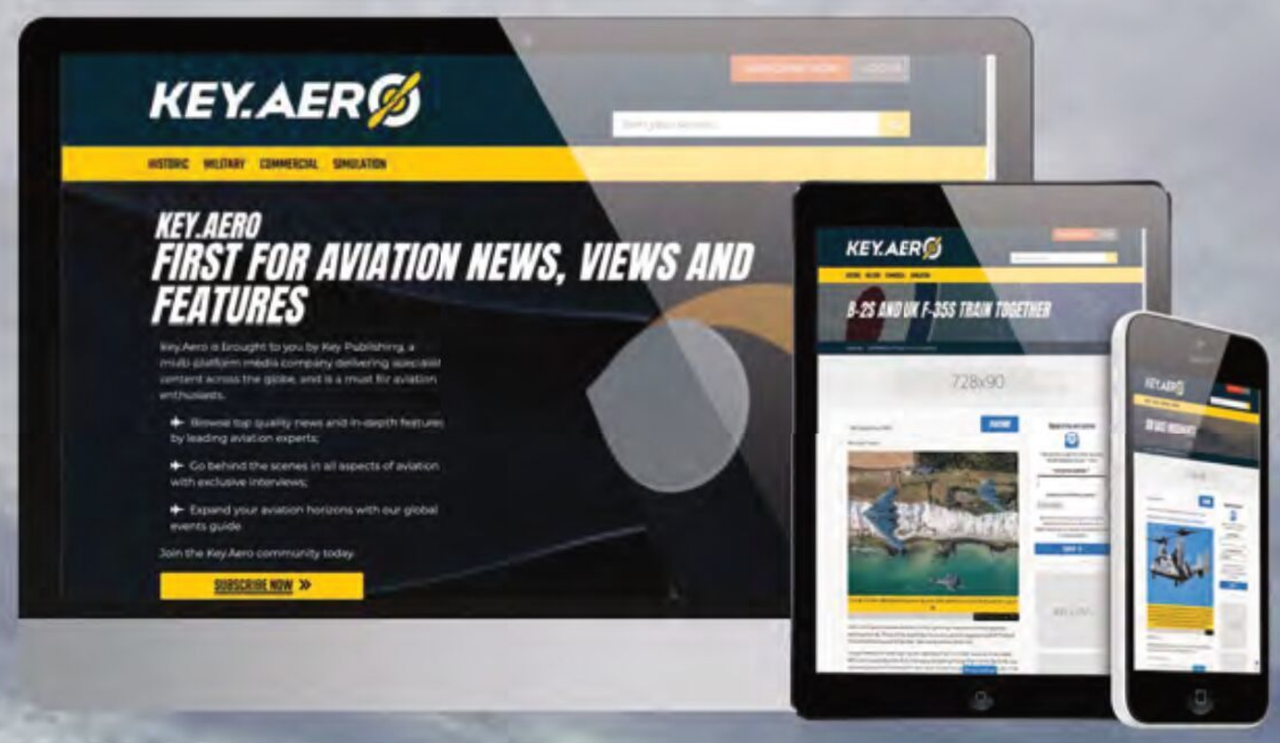
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**ABOVE: Britain's new aircraft carrier, HMS *Queen Elizabeth*, will sail on her first operational cruise in May 2021.** (MOD/CROWN COPYRIGHT)

**BELOW LEFT: France's primary carrier-borne aircraft is the Rafale multi-role combat jet, which are seen here on the FS *Charles de Gaulle*.** (PASCALSUBTIL)

**COVER IMAGE: The nuclear powered Nimitz-class super carrier, the USS *Carl Vinson*.** (US NAVY)

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# All at Sea

## Flat tops for the 21st century

**ABOVE: HMS *Queen Elizabeth* declared its initial operational capability in January 2021, ending a decade long gap in the Royal Navy's aircraft carrier capability.** (MOD/CROWN COPYRIGHT)

**RIGHT: Tim Ripley on the ski jump of HMS *Prince of Wales* during her visit to Liverpool in February 2020.** (TIM RIPLEY)

**BELOW: The US Navy's nuclear-powered super carriers still use catapults to launch their jets into action.** (US NAVY)

Stepping on to the flight deck of an operational aircraft carrier is an unforgettable experience. If fast jets are launching or recovering as disembark a helicopter or a carrier on-board delivery aircraft (COD) you are immediately immersed in a wall of noise, the heat of the jet engines almost scolds your face, and the smell of aircraft exhaust fumes is overwhelming.

Although modern carriers have dozens of supersonic jets flying off their decks, the unique feel and experience of stepping onto an aircraft carrier's flight deck has not really changed that much since the first carriers went to sea. The proximity to moving aircraft just cannot be replicated, whether it is a World War Two Swordfish or a modern F/A-18 Hornet.

The people who serve on aircraft carriers are also unique. The aircrew who put their lives on the line every time they are launched off a carrier's deck are a breed apart from land-based aviators. For the flight deck crew, working amid tons of moving aircraft can be just as dangerous.

Hopefully, this publication will convey many of these experiences, but we also aim to describe the story of how aircraft carriers became the premier naval weapon system and to look at how they are set to evolve to face the challenges of the 21st century.

This summer will see Britain's newest aircraft carrier, HMS *Queen Elizabeth*, set sail for her first operational cruise to the Far East. We will set the scene for this deployment, look at how HMS *Queen Elizabeth* and her sister ship, HMS *Prince of Wales,* were built, and explore their advanced capabilities.

While the technology of modern aircraft carriers is far in advance of that employed on those first aircraft carriers 100 years ago, one thing is constant. Aircraft carrier designers

and operators have continuously sought to incorporate new technologies at a rapid pace to secure advantage over their opponents. This trend continues today.

It seems certain that in 100 years' time there will still be warships at sea that look a lot like modern aircraft carriers. The things that fly off the carriers of the future will be very different and how they work inside will also have changed. However, the concept of a ship optimised to operate aircraft at sea is just so powerful and effective that it will probably never go out of fashion.

This publication tells the story of aircraft carriers over the past 100 years and will hopefully set the scene for another century of seaborne aviation.

**Tim Ripley**
May 2021

# What is a Super Carrier?

## The World's Biggest Warships

| THE WORLD'S SUPER CARRIERS IN 2021 | | |
|---|---|---|
| **Nation/Class** | **In Service** | **In Build** |
| **US Navy** | | |
| Nimitz-class | 10 | |
| Gerald R Ford-class | 1 | 3 |
| Wasp-class | 7 | |
| America-class | 2 | 2 |
| **Royal Navy** | | |
| Queen Elizabeth-class | 2 | |
| **People's Liberation Army Navy** | | |
| Type 001-class | 1 | |
| Type 002-class | 1 | |
| Type 003-class | | 1 |
| **Russian Navy** | | |
| Admiral Kuznetsov-class | 1 | |
| **Italian Navy** | | |
| Cavour-class | 1 | |
| Giuseppe Garibaldi-class | 1 | |
| **Indian Navy** | | |
| Modified Kiev-class | 1 | |
| **French Navy** | | |
| Charles de Gaulle-class | 1 | |
| **Japanese Maritime Self Defence Force** | | |
| Izumo-class | | 2 |
| **Spanish Navy** | | |
| Juan Carlos I-class | 1 | |
| **Australian Navy** | | |
| Juan Carlos I-class | | 2* |
| **Turkish Navy** | | |
| Juan Carlos I-class | | 1* |
| *Building under licence | | |

Super Carriers are best summed up as warships that are designed and built to routinely operate fixed wing, jet-powered aircraft.

When the first aircraft carriers were built a hundred or so years ago, they were often dwarfed by the battleships of that era. Today, aircraft carriers are the biggest warships afloat.

The term 'super carrier' has been in use since 1938 when it was applied to the then new HMS *Ark Royal*, which was the first aircraft carrier to incorporate a hangar and flight deck as an integral part of her hull. At the time she was one of the biggest aircraft carriers afloat at 22,000 tons but today's super carriers can be more than four times as big.

The super carrier tag came into more widespread use during the 1960s when the first nuclear powered carrier, USS *Enterprise*, took to sea at 93,000 tons. The subsequent Nimitz-class carriers then came in at more than 100,000 tons and they set the standard for super carriers over the following 50 years.

Today, super carriers are seen as not just those monster American vessels but also the flat tops of smaller navies that fly fast jets. These smaller carriers, as well as the US Navy's amphibious warfare vessels that operate jump jets as part of their air groups, are bigger that most World War Two-era aircraft carriers, such as the then class leader, HMS *Ark Royal*.

The variety of super carriers at sea today shows that the air power they can deploy is far in advance of that available on carriers of earlier generations. And even more capable ships are on the drawing board to be launched over the coming decade, demonstrating that carrier airpower and the ability to project power far beyond their home shores is still highly valued by navies around the world.

**ABOVE: The air wing or air group is at the heart of super carriers and their ability to project power.** (MOD/CROWN COPYRIGHT)

**BELOW: Modern aircraft carriers are far bigger than their World War Two counterparts, with the 65,000 ton HMS *Queen Elizabeth* being three times the size of the 1930s-era HMS *Ark Royal*.** (MOD/CROWN COPYRIGHT)

# HMS *Queen Elizabeth* Heads East

## The Royal Navy puts its new aircraft carrier to the test

**BELOW: Carrier Power Reborn. After a 10-year gap the Royal Navy is back in the aircraft carrier business.** (MOD/ CROWN COPYRIGHT)

As this special publication rolled off the presses, the Royal Navy's flag ship HMS *Queen Elizabeth* will have led the service's largest naval task group for more than a decade out of Portsmouth.

The deployment is the culmination of the Royal Navy's project to re-generate its aircraft carrier capability after the 2010 Strategic Defence and Security Review ordered the scrapping of the last Invincible-class carriers.

HMS *Queen Elizabeth* and the eight other ships of her task group were ordered to sail through the Mediterranean Sea, Indian Ocean and into the Eastern Pacific region. A visit to Japan is to be the highpoint of the deployment and then the ships will conduct joint exercises with ships and aircraft of the Japanese Maritime Self Defense Forces.

The build up to the deployment of the new ship has taken several years and the first preparations started to take shape after the carrier finally took to sea in June 2017 from the shipyard at Rosyth in Fife where she was built. This was the formal start of the entry service process of HMS *Queen Elizabeth*, which began with basic sea trails and then gradually built to more complex evolutions involving air operations in co-ordination with large task groups of surface ships and submarines.

In the autumn of 2018, HMS *Queen Elizabeth* sailed to the United States to embark Lockheed Martin F-35B Lightning jump jets for the first time. By the autumn of 2020, the carrier and her crew were ready to participate in the complex Joint Warrior exercise off the west coast of Scotland, prior to the Royal Navy declaring the ship's initial operating capability, or IOC, in January 2021.

The final composition of the task group, dubbed Carrier Strike Group 2021 or CSG21, was announced at the beginning of April 2021. Providing air defence protection are two Royal

**LEFT: The F-35B Lightning jump jet gives HMS *Queen Elizabeth* its long range strike power.** (MOD/CROWN COPYRIGHT)

Navy Type 45 destroyers, HMS *Diamond* and HMS *Defender*, and anti-submarine protection is provided by two British Type 23 frigates, HMS *Kent,* and HMS *Richmond*. At sea, logistic support is provided by the fleet tanker, RFA *Tidespring*, and solid support ship, RFA *Fort Victoria*. At least one Royal Navy Astute-class submarine is expected to accompany CSG21 to monitor underwater threats for part of the task group's mission.

## Multi National

Multi-national participants in CSG21 include the US Navy Arleigh Burke-class destroyer, USS *The Sullivans*, and the Royal Netherlands Navy frigate, HNLMS *Evertsen. The Sullivans* adds considerable capabilities to CSG21, including Tomahawk land attack cruise missiles and Standard theatre missile defence missiles.

The tailored air group embarked on HMS *Queen Elizabeth* includes eight F-35Bs from the Royal Air Force's 617 'Dambusters' Squadron and ten from the US Marine Fighter Attack Squadron 211 (VMFA-211). The deployment will also see the first mission for the Crowsnest airborne early warning variant of the AgustaWestland Merlin HMA2 maritime helicopters, operated by 820 Naval Air Squadron. This unit is also providing protection for CSG21 with its seven anti-submarine Merlins. To move people and supplies around the task group, three Merlin HC4 assault helicopters of 845 Naval Air Squadron are embarked on the carrier. These helicopters have the secondary task of launching Royal Marines of 42 Commando on combat search and rescue missions to recover any F-35B pilots who might be shot down in hostile territory.

The Type 45 destroyers and Type 23 frigates are all embarking four AgustaWestland Wildcat HMA2 maritime helicopters, which are equipped with the Thales Martlet anti-ship missile for their first operational deployment. Additional helicopter capability is provided by a NH Industries NH90 on the Dutch ship and two Sikorsky SH-60R Seahawks on the US destroyer.

The task group is led by RN Commodore Steve Moorhouse, who has amassed plenty of experience commanding carriers, including HMS *Prince of Wales* and HMS *Ocean.* In total some 3,700 personnel, nine ships, 18 aircraft and 17 helicopters will be under his command.

The plan was for the warships and squadrons of CSG21 to gather at HM Naval Base Portsmouth in early May and set sail for the west coast of Scotland to take part in a certification exercise to get the task group working as an integrated unit. Later in the month, they were to return to Portsmouth for final administrative activity and then set sail for the Mediterranean. »

**BELOW: The Crowsnest airborne early warning system is the eyes and ears of the HMS *Queen Elizabeth* carrier strike group.** (LOCKHEED MARTIN)

ABOVE: **Royal Navy Wildcat HMA2 helicopters are being equipped with the Martlet missile to protect Carrier Strike Group 21.** (LEONARDO)

## Diplomatic Considerations

The detailed programme of CSG21 was not fully revealed by the Royal Navy prior to the task group sailing because of diplomatic issues. The Ministry of Defence revealed in January 2021 that HMS *Queen Elizabeth* would sail to Japan for joint exercises with the Asian country's maritime forces. And in February, the ministry confirmed that CSG21 would carry out joint training with NATO allies in the Mediterranean and ships of the task group would make a foray into the Black Sea. However, HMS *Queen Elizabeth* would remain in the Mediterranean because an international treaty restricts access to the Bosporus of military ships heavier than 15,000 tons – essentially all aircraft carriers. However, her aircraft are available to fly missions in support of CSG21 warships within the Black Sea.

Once that phase of the deployment is complete the task group is to sail through the Suez Canal into the Red Sea. A port visit to Al Duqm in expected where the UK has a Joint Logistics Support Base, and the British company Babcock runs a dry dock that is big enough to accommodate a Queen Elizabeth-class carrier. The visit will test the ability of the British base to support carriers in the Middle East and Indian Ocean region, although on this occasion HMS *Queen Elizabeth* will not be taken out of the water.

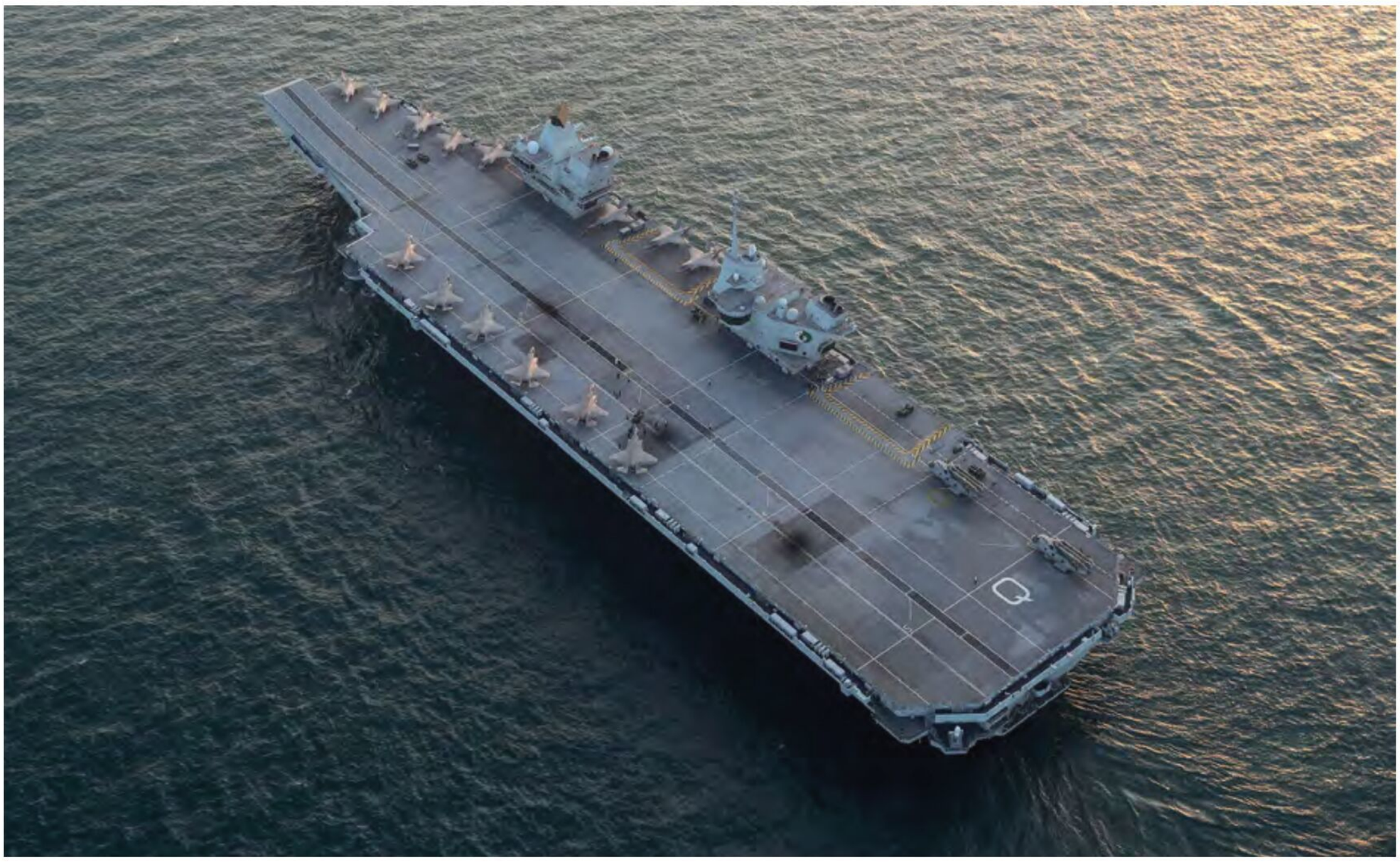
The next phase will see CSG21 exercise with the Indian Navy and possibly conduct joint air operations with its carrier, the INS *Vikramaditya*, as part growing UK and US co-operation with the south Asian country.

En route to the Pacific, a re-supply stop at Singapore, where the Royal Navy maintains another forward logistic base is expected.

Once past Singapore, the most sensitive part of the deployment will approach as the task force heads to Japan through the South China Sea. Australian warships are expected to join CSG-21 as it sails northwards. Tension with China over territorial disputes in this region will need to be navigated delicately by the Royal Navy and the British government. London has come out strongly in support of regional allies who are in dispute with Beijing and is keen to demonstrate freedom of navigation through the South China Sea. However, the British government will not want to get into shooting war with the Chinese People's Liberation Army Navy.

Once through the South China Sea, CSG21 will be in friendlier waters off Japan and South Korea where port visits are expected to take place to boost British trade with these powerful economies. The signing of a Maritime Security Arrangement with Japan earlier in 2021 is underpinning the visit of

BELOW: **HMS *Queen Elizabeth* is expected to be away from home for more than six months during the Carrier Strike Group 21 deployment.** (MOD/CROWN COPYRIGHT)



**LEFT: RAF and US Marine Corps F-35Bs will be embarked on the carrier for the Carrier Strike Group 21 deployment.** (MOD/CROWN COPYRIGHT)

**LEFT: HMS *Queen Elizabeth* will operate her jets across the Mediterranean Sea, Indian Ocean, and Pacific during the Carrier Strike Group 21 deployment.** (MOD/CROWN COPYRIGHT)

Royal Navy and was a clear sign of the waning influence of battleships in naval warfare.

For the Royal Navy, the Carrier Strike Group 2021 deployment will mark the start of new epoch in its history with its largest ever warships being proven to be fully operational and ready to project naval air power across the globe.

No doubt many lessons will be learnt during the CSG21 mission that will be put to good use in future deployments but the symbolism of a British aircraft carrier again being operational will not be lost on friends and potential adversaries. The Royal Navy will be well and truly back in the aircraft carrier business.

**BELOW: Air defence for HMS *Queen Elizabeth* will be provided by Royal Navy and allied frigates and destroyers.** (MOD/CROWN COPYRIGHT)

HMS *Queen Elizabeth* to the country, which has long standing links to the UK stretching back to the 19th Century when British shipyards built the Imperial Japanese navy's first modern battleships.

## Home by Christmas

After concluding its visit to Japan, CSG21 will retrace its course home and more exercises with allied navies and port visits are on the cards as the 20,000 nautical miles deployment concludes. If all goes well the whole task force is expected to back in Portsmouth by Christmas.

During her foray into the South China Sea, HMS *Queen Elizabeth* is expected to pass the location of the sinking of World War Two battleships, HMS *Prince of Wales,* **and** HMS *Repulse*, by Japanese aircraft in December 1941. This was a traumatic event for the

# Inside the Queen Elizabeth-Class Carriers

## Britain's New Super Warships

**BELOW: HMS *Prince of Wales* during her visit to Liverpool in February 2020.** (TIM RIPLEY)

Walking up to the top of HMS *Queen Elizabeth's* ski jump and looking back at her flight deck is the best way to appreciate that she is purpose designed and built to launch and recover aircraft in the most efficient and effective way. The carrier's 280 metre flight deck stretches into the distance and already aircraft towing vehicles are parked on the deck. On the carrier's aft island, the flying control, or Flyco, is up and running ready to oversee air operations on the ship – and her team of aircraft controllers could be seen at work through the Flyco's large windows.

A few days before she was to leave Rosyth to start her contractors' sea trials, HMS *Queen Elizabeth* was a hive of activity as the dockyard workers were in the final stages of removing their tools, scaffolding and temporary power supplies. Amid the coming and going of hundreds of men and women in hi-vis vests, the ship's company were carrying out their last damage control rehearsal exercises so HMS *Queen Elizabeth* could receive her certificate of seaworthiness. Just behind Rosyth dockyard's huge Goliath crane HMS *Queen Elizabeth's* sister ship, HMS *Prince of Wales*, could be seen in an advanced stage of assembly. Almost 20 years of effort to design, build and deliver a new generation of aircraft carriers for the Royal Navy was clearly nearing its fruition.

From afar, HMS *Queen Elizabeth* appears to have all the important features required of an aircraft carrier. First and foremost, a large flat deck to allow aircraft to take off and land from, as well as to park aircraft and helicopters before missions. It is also very big - at 65,000 tons –and can carry up to 40 aircraft or helicopters.

Once on board the ship, it becomes apparent very quickly that HMS *Queen Elizabeth* is not just your average aircraft carrier or even just a scaled down copy of the US Navy's Nimitz-class super carriers.

Visitors to the ship usually go aboard through the main hangar deck and it is immediately apparent how much space there is inside the ship. The hangar deck itself is 155 metres long and 33.5 metres wide, which is enough to take up to 20 F-35B Lightning jump jets or Merlin HMA2 anti-submarine helicopters. It is also high enough to stow Royal Air Force CH-47 Chinook heavy lift helicopters without having to remove their rotor blades. Two huge lifts are positioned along the side of the hull to move aircraft in and out of the hangar.

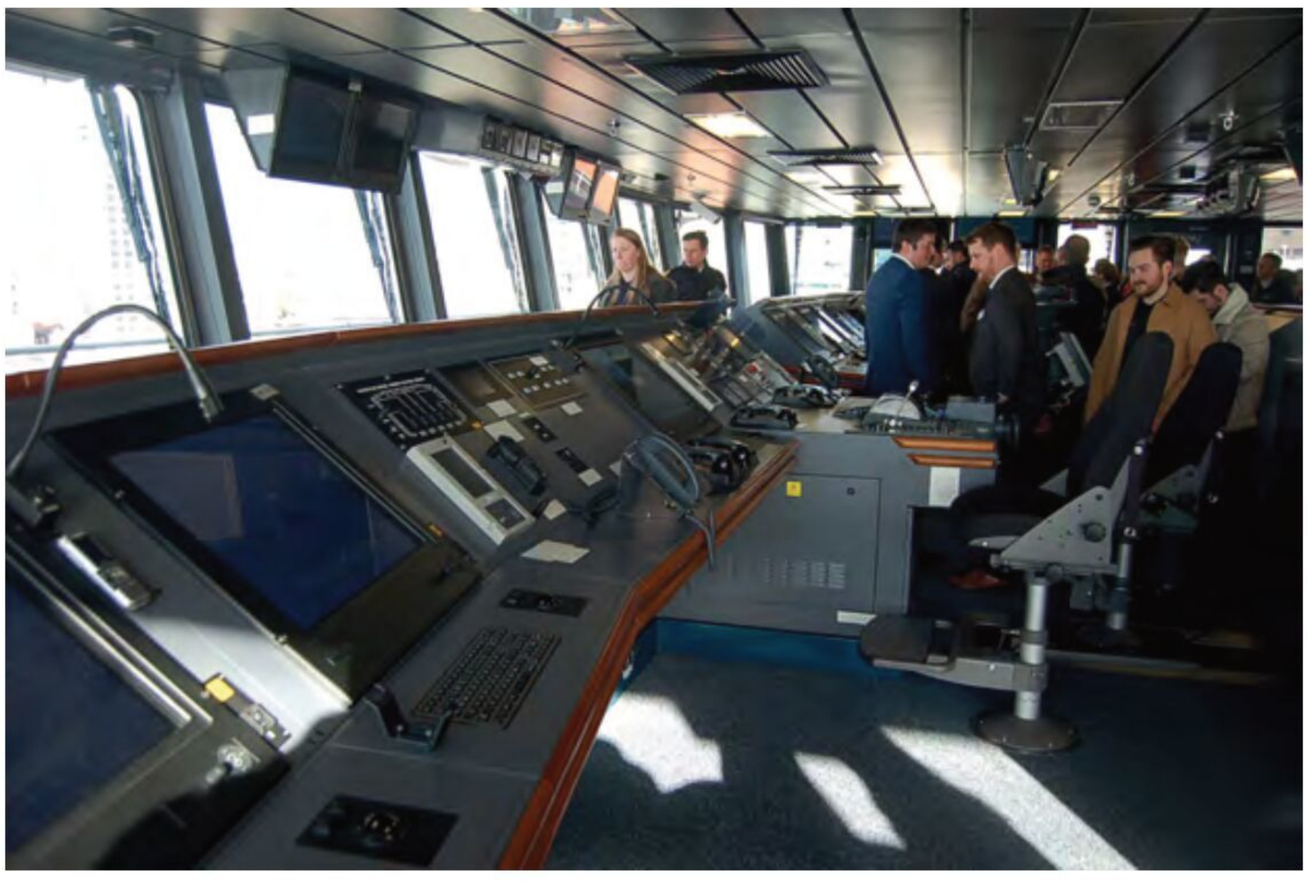
Along the hangar are a series of storage bays and workshops to

## Space and Efficiency

These ordnance lifts mean that complex weapons, such as laser guided bombs, can be pre-assembled down in the depths of the ship and, when they are needed, moved quickly up to the deck to be loaded on to F-35Bs. The ability to move large weapons and other cargo around inside the ship is a key feature of HMS *Queen Elizabeth* and her sister ship and this capability makes them unique. It dramatically reduces the number of personnel needed to crew the ship. The 65,000 ton British carriers are run by a ship's complement of 700 and an 800 to 900-strong air wing, which compares to the 3,500 sailors and 2,400 aviators and aircraft maintenance personnel required »

accommodate aircraft spares, tools and all the other kit needed to keep all the ship's aircraft operating at peak efficiency for the duration of operational deployments.

Around the hangar deck are a series of smaller lifts that allow pallets of cargo to be moved down into the depths of the ship without having to be unpacked or unloaded into smaller bundles. This means that cargo can be brought aboard in harbour, or via replenishment at sea or aerial delivery and then moved rapidly down into storage. Other lifts lead down to the ships' magazine to allow bombs and missiles to be moved up to hangar or the flight deck to be loaded onto aircraft in as efficient a way as possible.



**ABOVE: The ski jump and flight deck are the heart of the Queen Elizabeth-class carriers.** (TIM RIPLEY)

**LEFT: Commodore Jerry Kidd was the captain of HMS *Queen Elizabeth* during her first cruise.** (TIM RIPLEY)

**LEFT: Ship operations are directed from HMS *Prince of Wales*' bridge.** (TIM RIPLEY)

**ABOVE:** **Two giant aircraft lifts move the F-35Bs between the flight deck and the HMS *Prince of Wales*' giant hangar.** (TIM RIPLEY)

**RIGHT:** **Thousands of meals a day are prepared in HMS *Queen Elizabeth*'s kitchens, which are open around the clock when the ship is at sea.** (TIM RIPLEY)

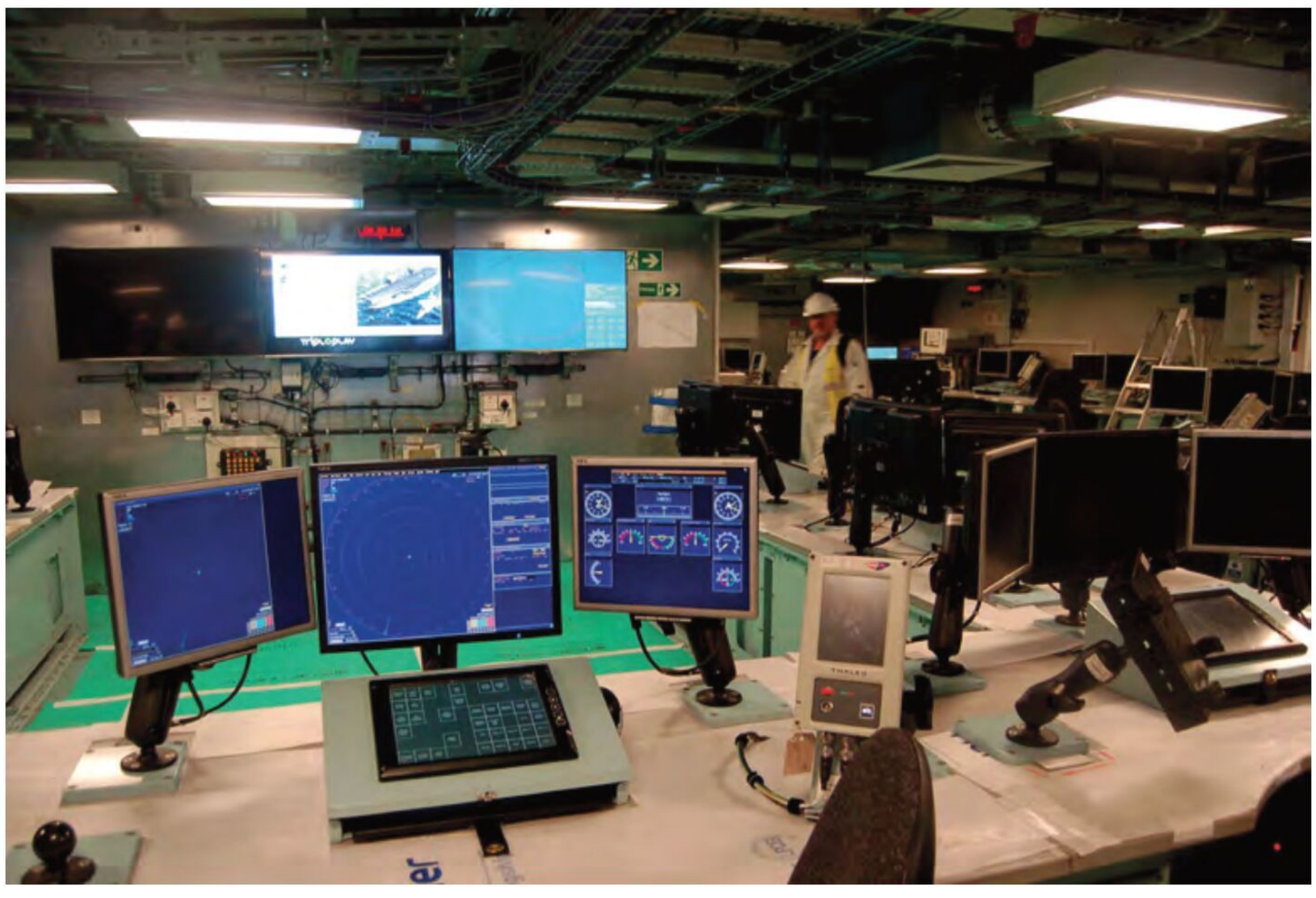
**BELOW:** **A computerised operations room controls HMS *Queen Elizabeth* and her supporting battle group during combat operations.** (TIM RIPLEY)

to crew a 100,000 ton Nimitz-class carrier. Ton for ton and sailor for sailor, the British carrier is more efficient by a factor of three.

HMS *Queen Elizabeth* is only 50 metres shorter than a Nimitz-class carrier, which illustrates the importance the British ship's designers placed on using space to create a more efficient vessel. Everything on HMS *Queen Elizabeth* is bigger than it needs to be to allow the crew to operate the ship more efficiently and to allow for future enhancements to be incorporated so she can remain in service for 50 years. Walking around the ship, this is immediately apparent. The corridors or passages are wide enough for two or three people at a time, ceilings are high, all the bulkhead doors are big, and the stairwells are wide as well. This allows the crew to move bulky items around the ship or for embarked Royal Marines to easily move through the ship when carrying their weapons, ammunition, and rucksacks.

HMS *Queen Elizabeth* is built to make life as comfortable as possible for her crew with sailors living in 470 cabins. During routine operations when just ship's crew and an air group are embarked, the lowest-ranked sailors live in six-person rooms but there is room to increase the capacity on the ship to 1,600 personnel.

To keep all these people working at peak efficiency, the carrier has five kitchens or galleys, manned by 67 catering staff including 40 chefs. These can produce more than 5,000 meals a day and enough food can be stored in her freezers and larders to feed the ship's crew for 45 days. To stop the sailors putting on extra weight, the ship has five gyms with cardio equipment, weights room and a boxing ring and training facility.



The feeling of space inside the ship compared to other Royal Navy warships or even Nimitz-class carriers is immediately apparent. This extends to the mess decks, kitchens and even the sailors' cabins.

Externally, the most distinctive feature of the carrier is her two islands, which each contain a funnel that increases the efficiency of the engine exhaust system. It also allows the ship's two radars to be mounted separately, making the vessel more stable. The forward island includes the bridge, where the captain and his crew can run the ship. In the rear island is the Flyco, where flying operations are co-ordinated. A large electronic sign is mounted on the side of the rear island to allow instructions and messages to be posted to inform the deck crew about what is happening. The F-35Bs and

helicopters generate so much noise that often radios or intercoms just don't work, even when deck crew are wearing hearing-protected helmets.

## The Ski Jump

At the bow of the ship is the ski jump to help the F-35Bs lift off when carrying a full weapon load. The ski lift was designed back in the 1970s when the old Harriers first embarked on the Invincible class aircraft carriers. It has since been adopted on Russian and Indian carriers. When walking across the deck of HMS *Queen Elizabeth* you can quickly see and feel the heat-resistant coating that has been applied to protect it from the hot jet exhaust created by the F-35B's unique lift fan. This metallic compound is made from aluminium and titanium and then sprayed on the landing spots on the flight deck. It is designed to withstand temperatures of 1,500°C

Down in the depths of the ship are her two Rolls-Royce Merlin Trent gas turbines that each produce some 48,000 horse power. Unlike in old-style warships, these turbines are not connected to propellers but work through four electrical generators that produce the power to turn the ship's two propellers. This 'electric drive' technology was first used in the Royal Navy's Type 45 destroyers, but it encountered many problems on these ships. The system used on the Queen Elizabeth-class carriers has not encountered the same teething issues.

Although the carrier's air wing is its main weapon system, the ship is provided with its own close-in self defence systems. Three Phalanx close-in weapon systems are positioned around the hull to provide 360° coverage to engage and neutralise in-bound missiles or low flying aircraft. Each weapon is based on a 20mm M61A1cannon, which has a rate of fire of up to 4,500 rounds per minute.

A second line of defence is provided by machine gun teams from the carrier's embarked company of Royal Marines. Their job is to deal with small boats or frogmen trying to approach the ship. When in port, the Royal Marines also provide security around the ship, guarding entry up the gangways and monitoring activity in the vicinity.

One of the most lasting impressions from a visit to HMS *Queen Elizabeth* is how new and modern she is. All her systems – from the electric drive to the cargo handling system and the F-35B jets themselves – are the newest and most advanced in the world. The ship is designed to last 50 years, so it is also laid out in such a way that allows future generations of sailors and naval engineers to retrofit the latest technology into her hull.

**ABOVE: Flight operations are controlled from the Flyco in the rear island of HMS *Prince of Wales*.** (TIM RIPLEY)

**LEFT: Sailors on HMS *Queen Elizabeth* have some of the most spacious accommodation on any Royal Navy warship.** (TIM RIPLEY)

# Building the Queen Elizabeth-Class Carriers

## Turning Concept into Reality

**BELOW: Both Queen Elizabeth-class carriers were assembled at Rosyth dockyard in Fife.** (MOD/CROWN COPYRIGHT)

The sailing of HMS *Queen Elizabeth* for her sea trials on June 26, 2017 was a major milestone in the project to close the Royal Navy's 'aircraft carrier gap', which was created by the 2010 Strategic Defence and Security Review. As part of a bid to cut the Ministry of Defence's budget, Britain's last strike carrier, HMS *Ark Royal* and her compliment of Harrier GR.9 jump jets were retired early, leaving the UK without fixed wing naval aviation for the first time since World War One.

The money saved was to be ploughed back into making sure the delayed and over budget HMS *Queen Elizabeth* and HMS *Prince of Wales* could actually be built. The cost of re-establishing what is termed the UK's carrier enabled power projection (CEPP) capability is truly eye watering, at some £6.2 billion to build the two carriers, £5.8 billion to buy 48 F-35B Lightning II joint strike fighters to fly from them and £300 million to buy Crowsnest airborne early warning radars for installation in the Fleet Air Arm's Merlin HMA.2 helicopters.

This was the culmination of more than 20 years of work by the Royal Navy, the British defence industry and senior government officials. Efforts to replace the old Invincible-class carriers began in the early 1990s and

**ABOVE:** **The hull blocks were joined together in Rosyth's giant dry dock and then floated out once the ship was complete.** (MOD/CROWN COPYRIGHT)

came to fruition in the 1998 Strategic Defence Review. This confirmed the requirement to build two large new aircraft carriers and for the UK to join the American Joint Strike Fighter (JSF) programme, which was in the early stages of building a replacement for the AV-8B Harrier and other combat aircraft. The JSF eventually became the F-35B Lightning.

The programme formally kicked off in 1999 when the Ministry of Defence contracted two teams, British Aerospace (now BAE Systems) and Thompson-CSF (now Thales) to prepare rival designs. In January 2003, the ministry picked the Thales design as the best but said it wanted BAE Systems to build the ships in its yards. This set in train the formation of what became known as the Aircraft Carrier Alliance, comprising BAE Systems, Thales and Babcock International. The maritime repair and services company was needed because they owned the Rosyth dockyard, a former Royal Navy base, which was the only naval shipyard in Britain with a big enough dry dock in which the new 65,000 ton carriers could be assembled.

## Block Assembly

A major part of the process in finalising the design was working out how to actually build such a big ship. It was eventually decided to go for a block assembly process, which saw several shipyards around Britain being contracted to build blocks of the carrier. These blocks would be pre-assembled with all the piping, decking, cabling, and major components. They were then shipped on giant barges to Rosyth, where they would be welded together to create fully formed aircraft carriers.

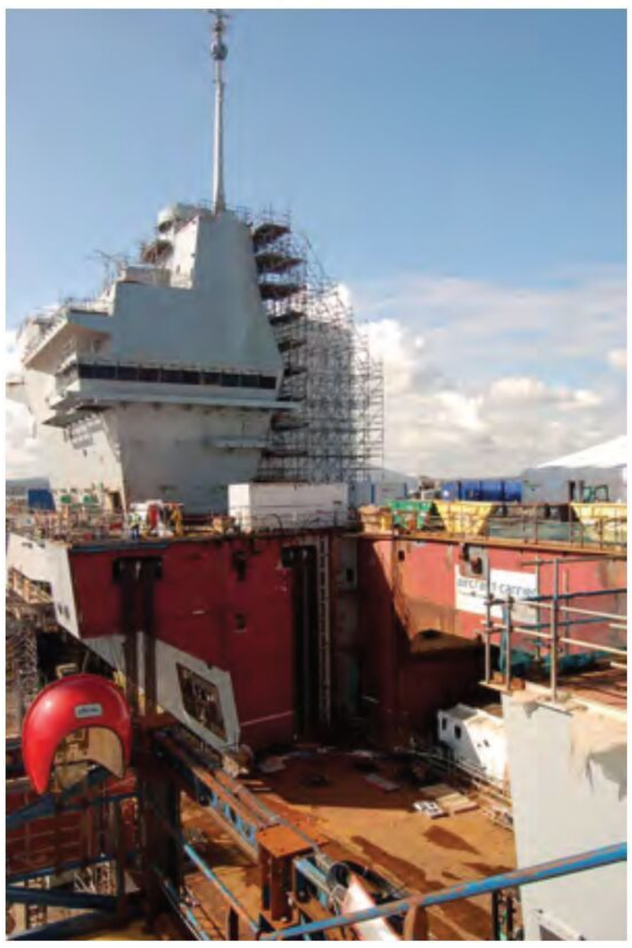
This was a revolutionary way of building large warships and it meant that a large proportion of the work on the carriers was carried out away from Rosyth. The two new carriers were the largest warships to be built since the 53,000 ton Audacious-class carriers in the 1940s and 1950s, so the UK shipbuilding industry had to start largely from scratch to work out how to build the ships.

After the first steel on the ships was cut in 2009, work accelerated and by the time HMS *Queen Elizabeth* was launched in 2014 it was too late to go back. In 2014 it was finally confirmed that HMS *Prince of Wales* would be brought into service on a full-time basis to allow the Royal Navy to maintain a 'continuous at sea' carrier presence. In the following year's defence review, the purchase of the full complement of 48 F-35Bs was confirmed to allow both carriers to simultaneously embark at least one squadron of jets.

Not surprisingly, in 2017 HMS *Queen Elizabeth's* first commanding officer, Commodore Jerry Kyd, said that the cost and hard work involved in »

**BELOW:** **Major components and hull blocks were built off site and then moved to Rosyth for assembly.** (MOD/CROWN COPYRIGHT)

**ABOVE: The carrier's flight decks are coated with heat resistant material to protect them from the super-hot exhaust of the F-35B Lightning jump jets.** (TIM RIPLEY)



**RIGHT: Major components, such as the giant aircraft lifts, had to be fitted during the initial build phase.** (TIM RIPLEY)

three major bridges across the Firth of Forth to start her four month-long contractors' trials programme to allow her to be handed over to the Royal Navy.

Eleven tugs were used to move the 280 metre-long ship out of the Aircraft Carrier Alliance's basin at Rosyth and position her in the Firth, before she started to pass beneath the bridges.

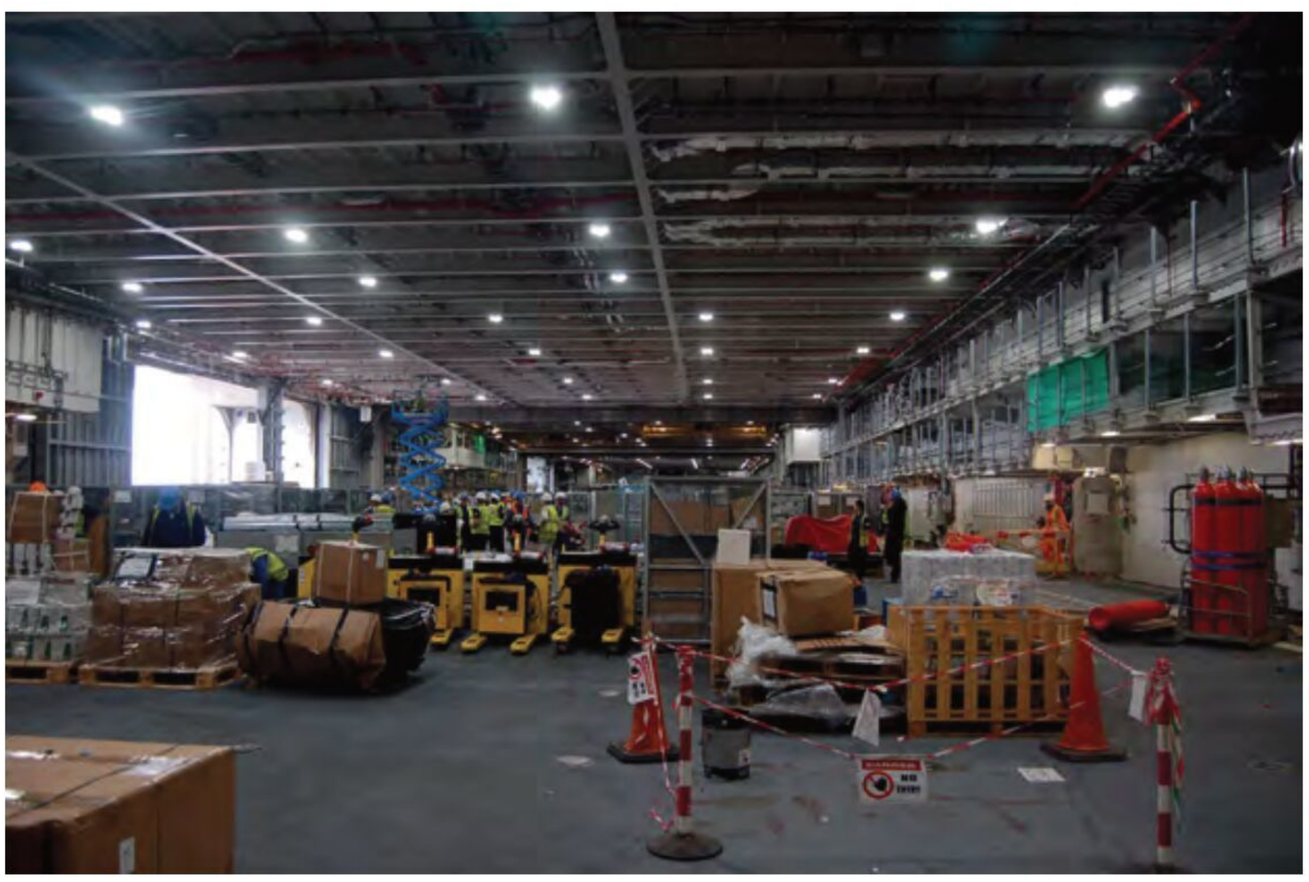
Prior to her sailing, Commodore Kyd described the complex evolution to get HMS *Queen Elizabeth* out the of basin where she had been under construction. "We need high water to go over the entrance [to the basin]. Then we will have to wait for the tide to go down so we can go under the bridges," he said.

During the contractors' sea trials, the focus was on proving whether HMS *Queen Elizabeth* met the Royal Navy's requirements, but Commodore Kyd stressed that operating aircraft was her primary function. "I want aircraft on board as quickly as we can," he said.

The need to bring HMS *Queen Elizabeth* into dry dock for inspection, overhaul and capability insertion means that the second carrier needs to be online to cover any gaps. France had only been able to afford to build one nuclear powered aircraft carrier in the 1980s and 1990s and this meant there were long periods when she was not available for operations.

getting her to sea, would be worth the effort. "The premier nations of the world are investing billions of dollars in aircraft carriers," he said on the bridge of his ship, just before she was to sail for the first time . "The ship will provide the British government with an incredibly flexible tool. We are globally outward nations. HMS *Queen Elizabeth* and her sister ship, HMS *Prince of Wales*, are to give Britain a global presence. Anywhere she goes in world it will give Britain a serious punch."

The 65,000-ton HMS *Queen Elizabeth* was manoeuvred out of the dockyard's basin on June 26, 2017, and later that evening passed under the



**RIGHT: At the heart of the carrier is a giant hangar that can accommodate more than 20 jets or helicopters.** (TIM RIPLEY)

"Two carriers mean continuous availability so politicians can decide how to use them," said HMS *Prince of Wales*' senior naval officer, Captain Ian Groom in 2017 . "Politicians need to have carrier strike availability at the time of their choosing – they need HMS *Prince of Wales* to give them that."

The completion of HMS *Prince of Wales* followed along in the wake of HMS *Queen Elizabeth* and she was formally accepted in Royal Navy service in December 2019. This meant the process of regenerating the Royal Navy's carrier strike capability was initially set for December 2020. and full operating capability due by 2023.

A key part of bringing the two carriers into service was the integration of the aircraft and the naval air squadrons on board the ship and with the Royal Navy's carrier battle group. This was particularly important for the F-35B, which had never operated from any Royal Navy ship before and involved revolutionary lift-fan technology. The ship's decks had been protected by specially designed heat-resistant coatings, but this had never been tested for real on a ship at sea.

HMS *Queen Elizabeth* first went to the east coast of the United States of America for F-35B integration trials run by the US Navy's Air Systems Command and the aircraft's manufacturer, Lockheed Martin, which involved specially instrumented aircraft making the first deck landings and take-offs from the ship. The next phase involved work up training with in-service aircraft from the RAF's 617 Squadron in US and home waters.

Training the ship's crews to operate her systems and work on her flight deck was just as important as training the aircrew. A mock aircraft carrier deck was laid out at RNAS Culdrose to help train up deck crews and aircraft handlers.

Major investments were also made at HM Naval Base Portsmouth to make it the home port of the carriers. This included additional dredging of the harbour channel to allow the carriers to enter the base, as well as shore-side infrastructure. A new jetty is also being built at Glen Mallen on Loch Long to allow ammunition, including aircraft bombs and missiles, from the Glen Douglas ordnance depot to be loaded onto the new carriers.

Building the Queen Elizabeth-class aircraft carriers has been a national project that is now coming to fruition.

**ABOVE: HMS *Queen Elizabeth* returned to Rosyth for a dry-dock period in April 2019 to allow her hull to be inspected, as HMS *Prince of Wales* was in the final stages of assembly.** (AIRCRAFT CARRIER ALLIANCE)

**BELOW: HMS *Prince of Wales* sets sail for the first time from Rosyth in September 2019.** (MOD/ CROWN COPYRIGHT)

# History of Aircraft Carriers

## The Age of the Flat Top

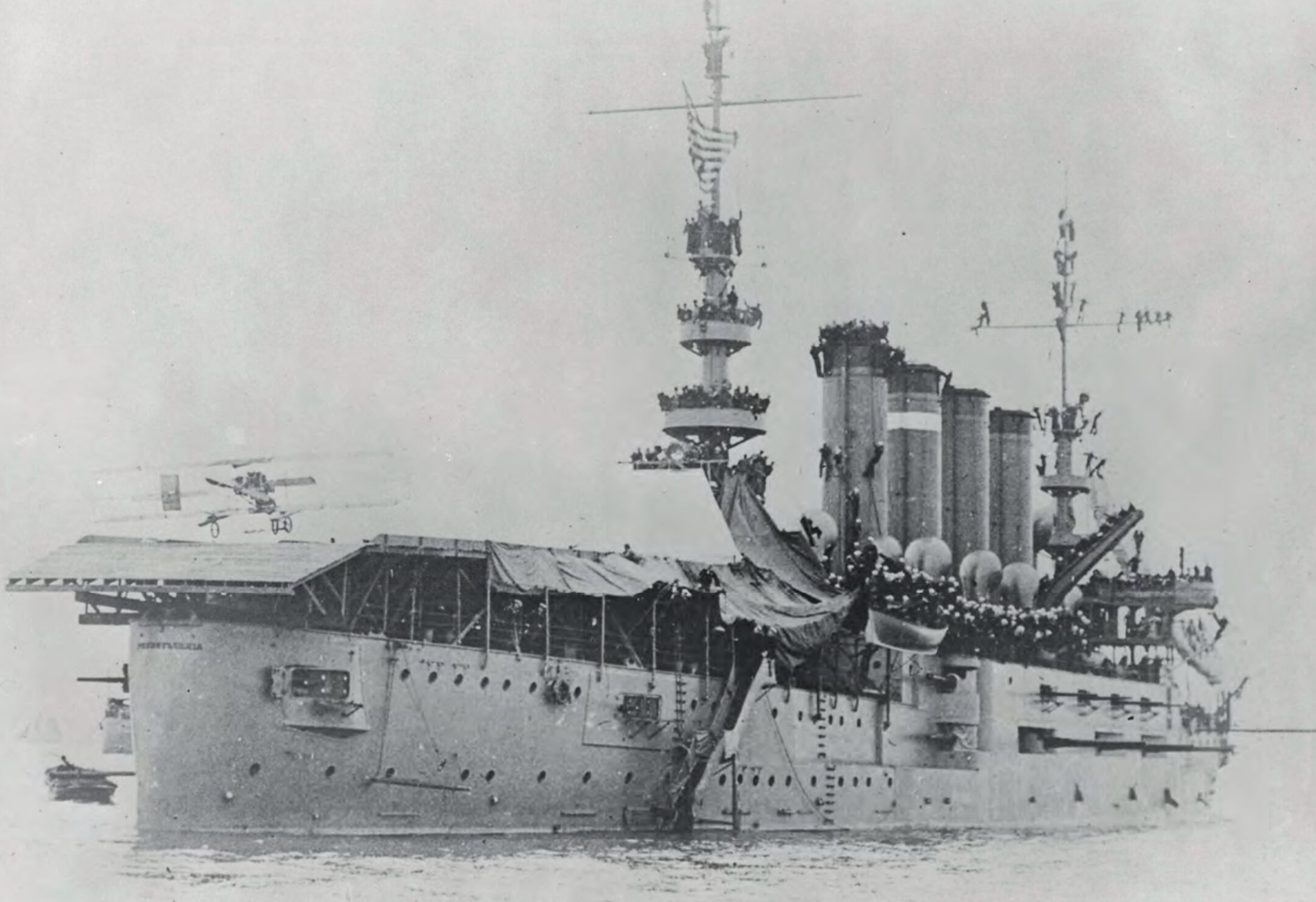
**BELOW: Eugene Ely landing his plane on board USS *Pennsylvania* in San Francisco Bay on January 18, 1911 to make the first fixed-wing aircraft landing on a warship.** (US NATIONAL ARCHIVES)

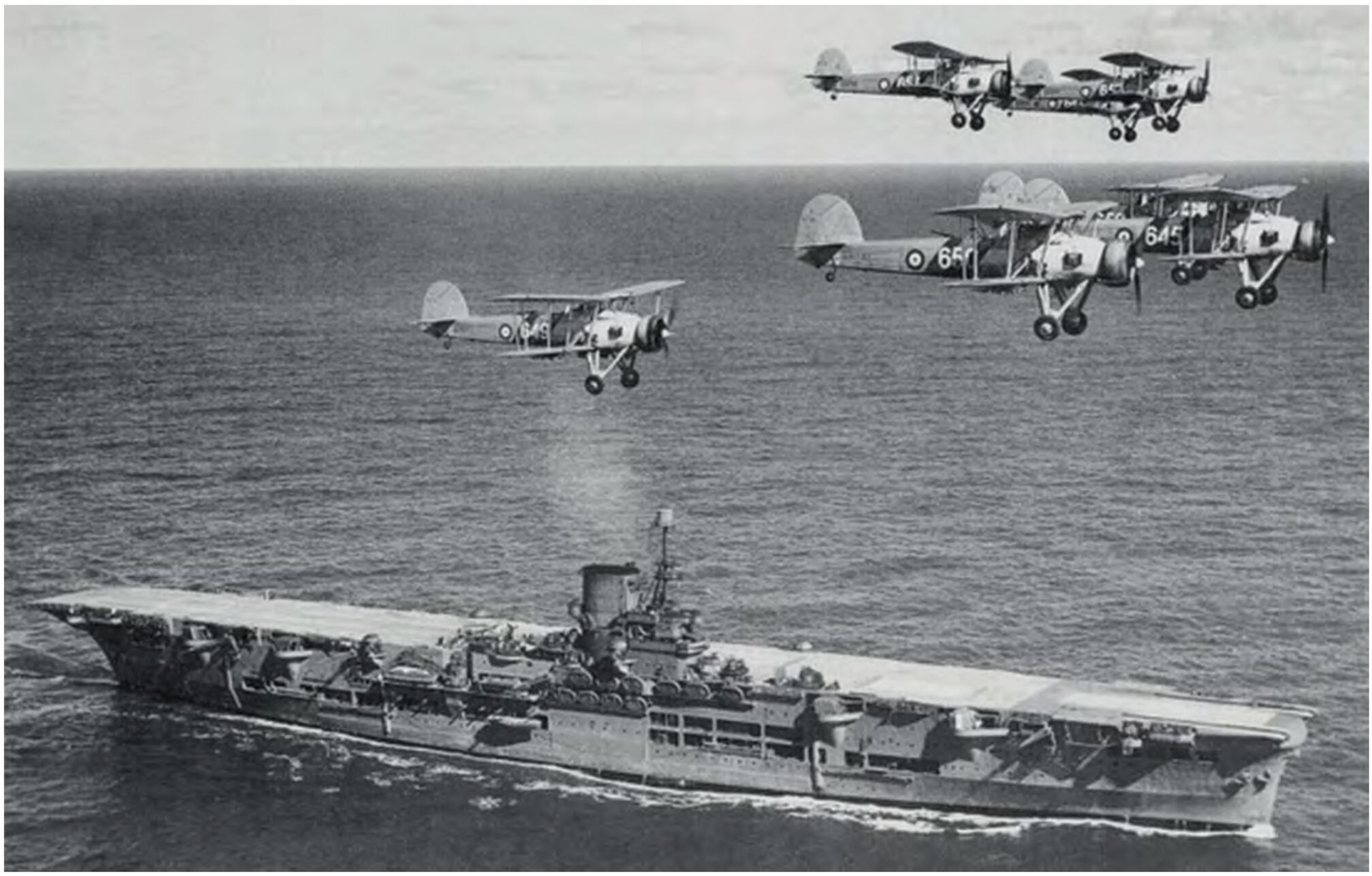
Flying from the deck of warships has a long history stretching back to World War One when several navies experimented with different methods of launching and recovering aircraft.

The first heavier-than-air aircraft was launched off a warship in 1910 when aviation pioneer Eugene Ely flew his Curtiss Pusher off an improvised platform on the forward turret of the USS *Birmingham.* A few months later, he repeated the feat on a larger platform on the USS *Pennsylvania* and then was able to turn his aircraft around to take off a few minutes later.

In May 1912, Royal Navy Commander Charles Rumney Samson became the first airman to take off from a moving warship. He lifted off in a Short S.38 from the battleship HMS *Hibernia* while she steamed at 15 knots (17 mph; 28 km/h) during the Royal Fleet Review at Weymouth, England. Just over two years later, the Royal Navy launched the first ever warship dedicated to operating aircraft. The first HMS *Ark Royal* was originally intended be a merchant ship but mid-way through her construction, navy chiefs decided to fit her with a flat deck to allow the ship to launch and recover sea planes. Within months, another carrier, HMS *Furious,* was under construction and in 1917, Squadron Commander E.H. Dunning made the first landing on the ship as she was underway in Scapa Flow off Orkney. He was killed five days later, attempting to repeat the feat. The recovery of aircraft on carriers had yet to be mastered.

HMS *Furious* was used in anger for the first time in July 1918 when she launched seven Sopwith Camels to drop improvised bombs on the German Zeppelin base at Tondern. Several of the German airships were destroyed or damaged in the raid but the British naval aviators had no way





of landing back on the ship, so either had to ditch in the sea next to HMS *Furious* or land in neutral Denmark.

In the 1920s and 1930s the Royal Navy led the way, experimenting with bigger and better aircraft carriers, as well as developing the aircraft and weapons to fly off them. The first warship that was able to routinely launch and recover powered aircraft was HMS *Argus,* which for the first time boasted a large flat deck for aircraft to launch from and recover on.

This was a period of transition between the dominance of the battleship and the rise of the aircraft carrier, as the main type of capital ship. The British, US and Japanese navies were the leaders in the drive to build bigger and better aircraft carriers, as well as to field purpose-built aircraft to operate from flat tops. Revolutionary thinkers in navies around the world could see the potential of the carrier and an embarked air group but it had not been proved in battle.

This changed on November 11, 1940 when the carrier HMS *Illustrious* launched a strike force of Fairy Swordfish torpedo bombers to attack the main port of the Italian fleet at Taranto. The Italians were taken by surprise by the daring strike and in a matter of minutes, half the Italian fleet was at the bottom of the harbour. Only two Swordfish were lost in the attack.

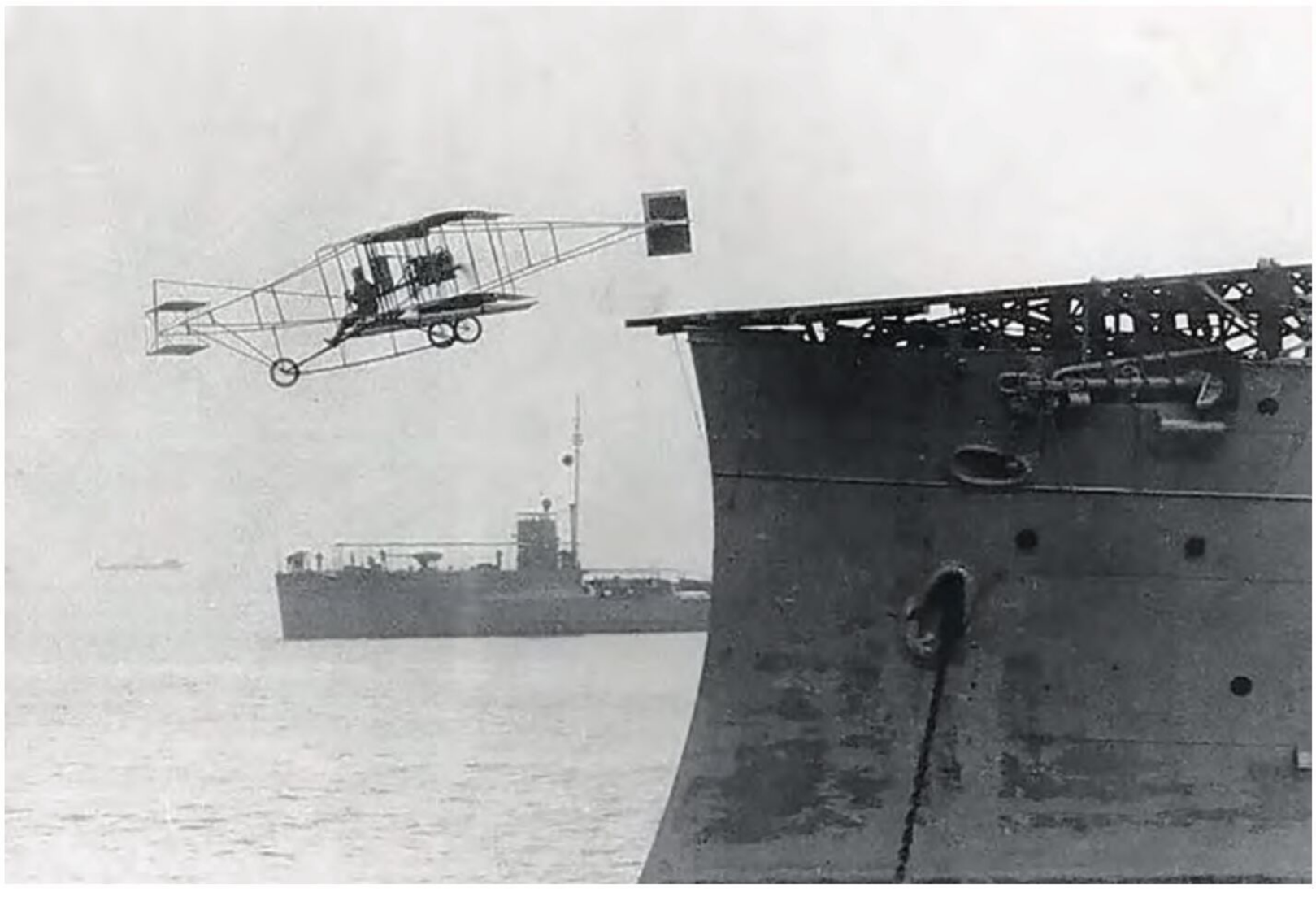
The supremacy of British naval airpower was demonstrated again six months later when more Swordfish, launched from the second carrier to bear the name HMS *Ark Royal*, found and crippled the German battleship *Bismarck* in the North Atlantic.

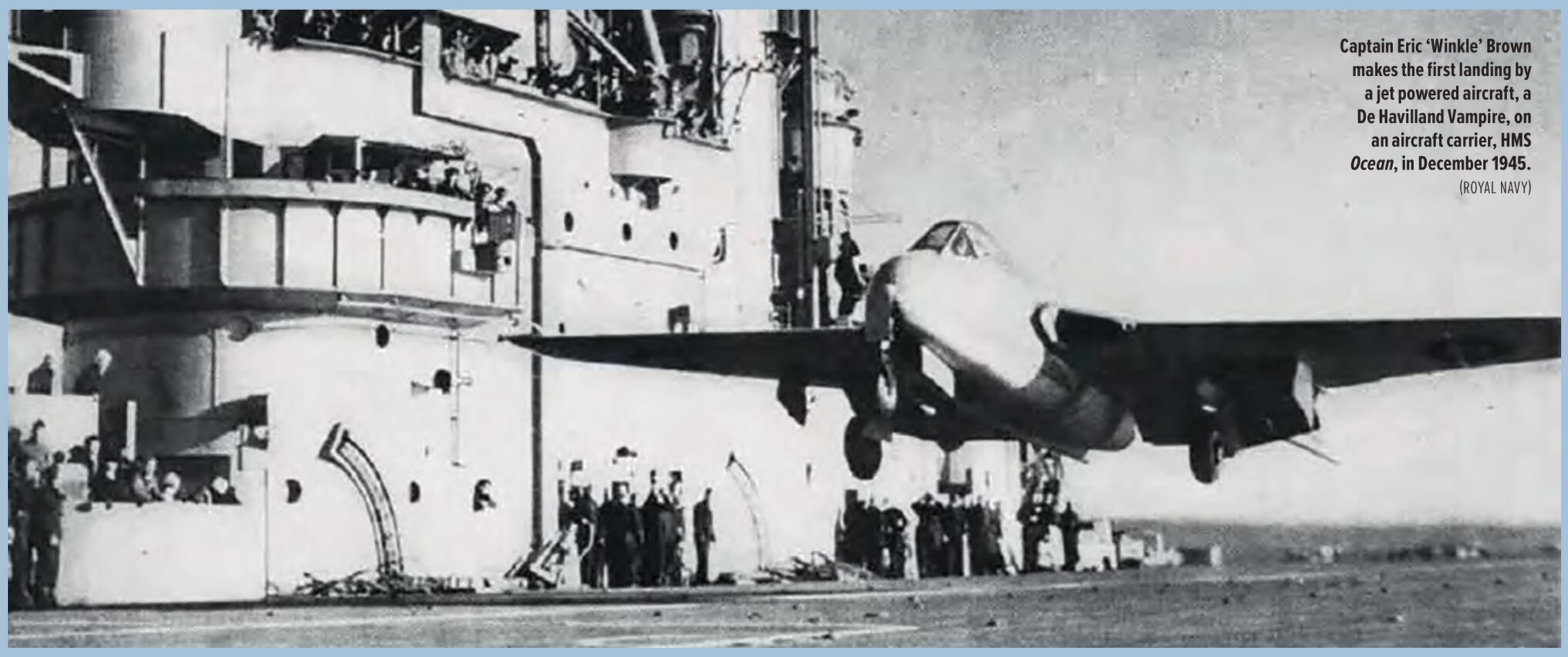
But it was the Japanese attack on the US Navy base at Pearl Harbor on December 7, 1941 that really put carrier aviation on the map. The crippling of the US Pacific Fleet in a matter of hours showed that the aircraft carrier was now the dominant naval weapon. Over the next four years, the US and Japanese carrier fleets duelled across the Pacific. The Americans dealt a major blow to the Japanese at Midway in June 1942 and then the US Navy's carriers went on to systematically destroy Tokyo's fleets.

Just as the US Navy was basking in the glory of its success against the Japanese, the advent of jet power was making all the World War Two-era carrier-borne aircraft redundant. Britain's Eric 'Winkle' »

**ABOVE: When she was launched in 1937, HMS *Ark Royal* was the first aircraft carrier on which the hangars and flight deck were an integral part of the hull.** (ROYAL NAVY)

**BELOW: Eugene Ely takes off from the USS *Birmingham* on November 14, 1910, to become the first man to successfully fly a powered aircraft off a warship.** (US NAVY)





**Captain Eric 'Winkle' Brown makes the first landing by a jet powered aircraft, a De Havilland Vampire, on an aircraft carrier, HMS *Ocean*, in December 1945.**
(ROYAL NAVY)

**ABOVE: HMS *Formidable* on fire after being hit by a Japanese kamikaze plane while supporting the US invasion of Okinawa in May 1945. Her armoured flight deck and hangar prevented serious damage and she returned to service after repairs.**
(ROYAL NAVY)

Brown landed a de Havilland Vampire jet on HMS *Ocean* in December 1945, setting off a race to take the heavier, larger, and faster jet aircraft out to sea.

New generations of aircraft carriers needed to be built to accommodate the larger and heavier jet-powered aircraft. In 1948 the Royal Navy added an experimental angled flight deck to HMS *Triumph* to see if it was possible to increase the tempo of launching and recovering aircraft. This meant the aircraft could land on a carrier without putting aircraft parked on the front flight deck at risk. An experimental steam-powered catapult was tested on HMS *Perseus* in 1950. This opened the way for heavy aircraft with large weapon loads that would otherwise need a long runway to get airborne to be launched off carriers. Two years later, the Royal Navy installed the first optical landing system on a carrier to allow the pilots to line up safely to put their aircraft down on the best spot to catch arrestor wires. Catapult and arrestor wires became known as 'cats and traps' .

The golden age of British aircraft carriers, in the 1950s and 1960s, saw the Royal Navy fielding jet fighters, airborne early warning aircraft and anti-submarine aircraft from their decks. However, ambitions by the Admiralty to build a new 63,000 ton super carrier, the CVA01, in the 1960s were scuppered by defence cutbacks.

The US Navy had no such problems. Strong backing from Congressional leaders, such as Carl Vinson and John C Stennis, meant that the money kept flowing to build bigger and better aircraft carriers. Both subsequently had carriers named after them.

World War Two-era carriers had angled flight decks fitted but in 1952 the first Forrestal-class carrier was laid down that incorporated angled flight decks, steam catapults and optical landing systems as standard. Three 60,000 ton Forrestal-class and three 61,000 ton Kitty Hawk-

**The world's first nuclear-powered aircraft carrier, the USS *Enterprise*, entered US Navy service in 1961.**
(US DOD/COMBAT CAMERA)

class super carriers followed in the 1950s and 1960s.

The next big leap in aircraft carrier design began in 1958 when the keel was laid on the first nuclear-powered carrier, USS *Enterprise*. She was commissioned in 1961 and at the end of the decade work began on the first of the 100,000 ton Nimitz-class super carriers. Over the next 40 years ten Nimitz-class carriers would be built and these cemented the position of the US as the world's dominant naval power.

Britain's Royal Navy continued to suffer from budget cuts and retired its last 'cats and traps' carrier, HMS *Ark Royal*, in 1978. To try to compensate for this loss the navy began building its three Invincible-class carriers that served with distinction in 1982's Falklands war. These 22,000 ton carriers became forever linked to the Sea Harrier fighters that ruled the skies over the Falklands.

Around NATO and other western countries, the sheer cost of operating carriers forced them to retire their 'cats and traps' carriers during the 1970s and 1980s. A handful of navies, including India, Italy, Spain, and Thailand, opted to follow the British example and buy Harrier jump jets to operate alongside helicopters on simple flat tops.

America's great Cold War rival, the Soviet Union, did not sit by as the US Navy surged ahead in the race to field aircraft carriers. In the 1970s the Soviet Union started work on its first aircraft carrier, the *Kiev*, capable of launching fixed wing aircraft in the shape of the Yak-38M jump jet. By the end of the 1980s, four Kiev class carriers were in Soviet Navy service and work was under way to build two new Kuznetsov-class carriers that were designed to operate supersonic fast jets, including the carrier variants of the Sukhoi Su-33 and Mikoyan MiG-29. They never entered service with the Soviet navy, with only one joining the new Russian navy and the other being sold to China. The last gasp of Soviet carrier development was the laying down in 1988 of the 85,000 ton nuclear-powered super carrier, the *Ulyanovsk*. She was only 40% complete in a shipyard in the newly independent Ukraine when the Soviet Union dissolved in 1991. Within months the monster ship was being broken up for scrap, providing a fitting monument to the folly of the Cold War arms race.

**ABOVE: The F-14 Tomcat was the US Navy's last purpose-designed air supremacy fighter, seen here on the USS *Saratoga's* catapult.** (US NAVY)

**BELOW: The British-designed Sea Harrier was the first VSTOL aircraft to participate in combat operations in the 1982 Falklands war. One of the jump jets is seen here landing in the MV *Atlantic Conveyor* to test the container ships' suitability to act as an aircraft ferry to take Harriers, Sea Harriers, and helicopters to the South Atlantic.** (ROYAL NAVY)

**The iconic Swordfish or 'Stringbag' entered Royal Navy folklore by executing the first ever successful carrier strike operation at Taranto.**
(TONY HISGETT)

# The Battle of Taranto

## The First Carrier Victory

At the start of World War Two, aircraft carriers were still largely unproven in combat. When the war broke out in September 1939 only Britain, Japan and the United States had fully operational aircraft carriers. For more than two years, until the Japanese carrier strikes on the US naval base at Pearl Harbor, only the Royal Navy's carriers were in the fight.

When Italy entered the war on the side of Germany in the summer of 1940, the Royal Navy's Mediterranean Fleet had to battle to keep open vital sea lanes to Gibraltar, Malta, and Egypt. The commander of the Mediterranean Fleet, Admiral Andrew Cunningham, ordered his staff to work up plans to knock out the Italian navy, or *Regia Marina,* and remove it as a threat to maritime traffic to and from beleaguered British outposts in Malta and Egypt. For several months they had been considering a daring surprise strike by carrier-borne Swordfish torpedo bombers against the Italian fleet

while it was at anchor in its home port, Taranto. The port was located at the 'heel of the boot' on Italy's southern coast and the British strike force would have to approach within 200 miles before it could launch the Swordfish.

To achieve surprise, the British choreographed a complex operation to keep the Italians guessing while HMS *Illustrious* manoeuvred into position in the Ionian Sea. Other Royal Navy warships put to sea from Malta, Alexandria and HMS *Ark Royal* made a foray from Gibraltar towards Sardinia. The strike on Taranto was code-named Operation Judgement.

The target for HMS *Illustrious* on the evening of November 11, 1940 was the *Regia Marina*'s First Squadron's anchorage at Taranto, where six battleships, seven heavy cruisers, two light cruisers and eight destroyers were at anchor. Nearly 300 anti-aircraft guns, 27 barrage balloons and dozens of searchlights ringed the port and were waiting for the Fleet Air Arm fliers.

Two waves of Swordfish were launched from the carrier into the darkness just after 9pm before heading towards Taranto. In the first wave there were six aircraft armed with torpedoes, four armed with bombs and two loaded with flares. After a two hour flight the first wave arrived over the harbour and the aircraft broke off to attack their targets. Illuminated by the flares, the first group of three torpedo bombers successfully attacked the battleship IS *Conte di Cavour* and then another group hit the IS *Littorio*. The bomber

group attacked a pier, hitting two moored cruisers, and then struck at large fuel tanks. A wall of anti-aircraft fire from both ships and shore batteries greeted the arriving aircraft. One of the British planes was hit but the crew survived and were captured.

The second wave lost one aircraft in an accident on take off, so only eight aircraft made it to Taranto, arriving just before midnight. Illuminated by the flares, five torpedo-armed Swordfish successfully attacked the battleships IS *Littorio* and IS *Duilio* and the remaining aircraft made dive bombing attacks on other ships. One of the final aircraft was shot down with the loss of the crew.

By 02.39am, the last Swordfish had returned safely to HMS *Illustrious,* and the carrier could turn for home. The Fleet Air Arm pilots would have to wait several days until aerial photographs showed the extent of the damage they had caused. The strike had disabled three battleships and damaged a heavy cruiser and two destroyers. Nearly 60 sailors were killed and some 600 wounded.

Italian anti-aircraft defences had proved of limited effect and the *Regia Marina* was not able to spread enough torpedo nets to completely protect its ships. Crucially, a modification to allow the Swordfish's torpedoes to work in less than 40 feet of water, rather the previously required 75 feet, meant the weapons worked successfully in the narrow water of the Taranto anchorage.

Although most of the Italian ships were eventually repaired, at a stroke the Royal Navy had effectively put half of the Italian's capital ships out of action for a considerable time, just at the point where the British needed freedom of manoeuvre in the Mediterranean. Admiral Cunningham was quick to praise the Swordfish crews, saying "Taranto and the night of November 11, 1940 should be remembered forever as having shown once and for all that in the Fleet Air Arm, the Navy has its most devastating weapon."

For the first time in warfare, aircraft carriers had inflicted a heavy blow against an enemy fleet. One unintended consequence of the British strike on Taranto was felt in the Pacific. Japanese naval officers in Italy visited the port after the attack to report on the effectiveness of British torpedoes. Little over a year later, the Japanese fleet would stage a similar attack – on a significantly larger scale – against the US Pacific Fleet at Pearl Harbor with devastating results.

**LEFT: The commander of the Royal Navy Mediterranean fleet, Admiral Andrew Cunningham, made the daring decision to strike at Taranto.** (ROYAL NAVY)

**BOTTOM LEFT: The Italian navy thought its anchorage at Taranto was safe from attack.** (ROYAL NAVY)

**BELOW: The Italian battleship ITS *Littorio* was badly damaged during the Royal Navy attack.** (ROYAL NAVY)

# Midway 1942

## Carrier vs Carrier Action

**BELOW: Japanese aircraft struck back on June 4, hitting the USS *Yorktown* with multiple torpedoes.** (US NATIONAL ARCHIVES)

The Japanese attack on the US naval base at Pearl Harbor on December 7, 1941 was a dramatic demonstration of the power of Tokyo's aircraft carrier fleet and signalled that naval air power would dominate the struggle in the Pacific.

Although the Japanese air strikes devastated the US Pacific Fleet - sinking four battleships and severely damaging 14 others, as well destroying 188 aircraft, and damaging a further 159 others – the US Navy aircraft carriers were at sea and escaped without a scratch.

Japan's naval supremo, Admiral Isoroku Yamamoto, wanted to finish off the American carriers. He planned to launch an amphibious attack on the island of Midway, some 2,100 kilometres to the west of the Hawaiian Islands to draw out the remaining US carriers in the central Pacific. Once the Americans had taken the bait, Yamamoto would unleash his four carriers to sink the US flat tops.

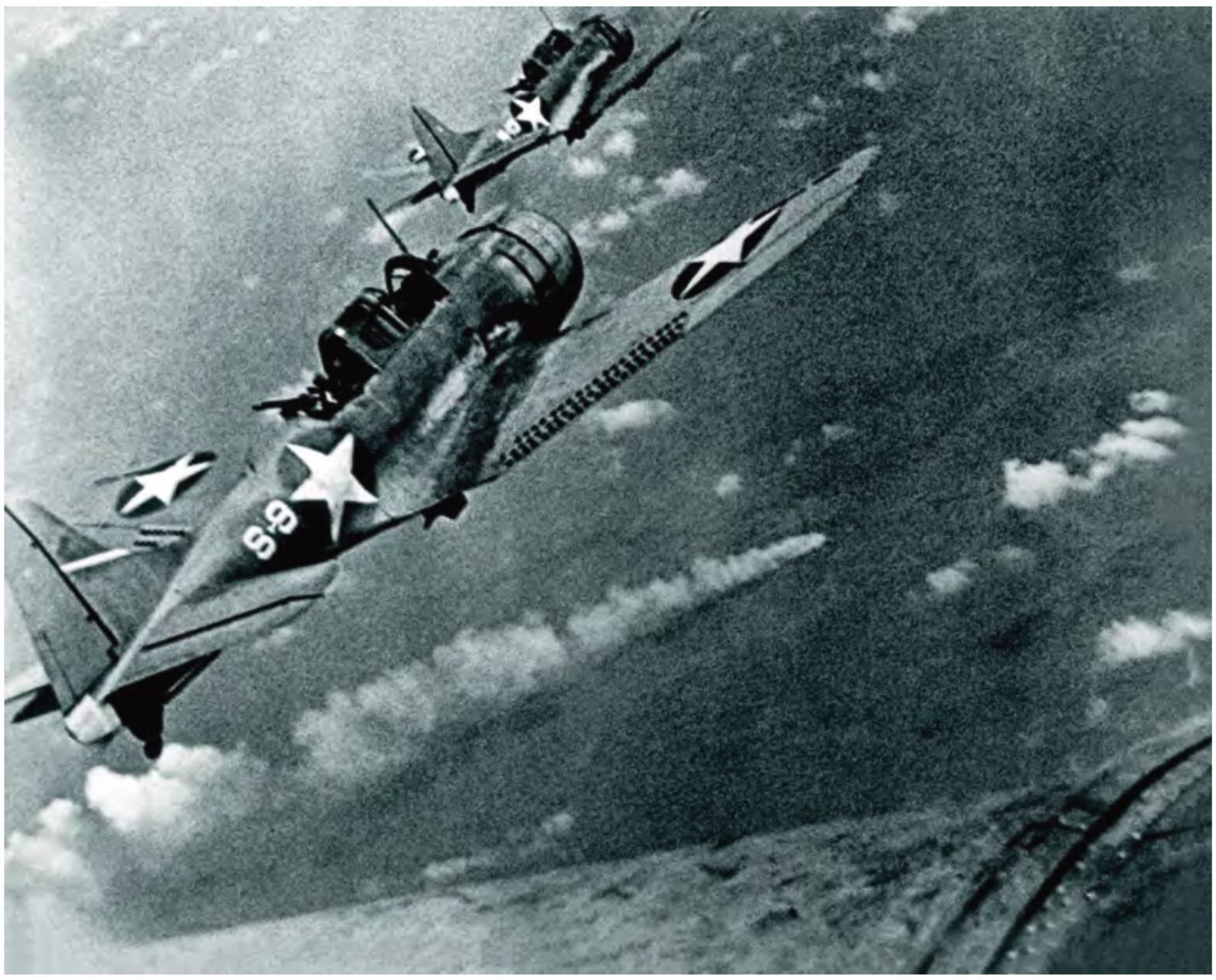
Fortunately for the American naval commander, Admiral Chester Nimitz, US intelligence had broken the Japanese naval codes and had worked out how to frustrate Yamamoto's plan. Nimitz beefed up defences on Midway to hold off the Japanese invasion, but he sent his carriers to intercept the Japanese carriers. Dockyard workers at Pearl Harbor had worked around the clock to repair the USS *Yorktown* and she put back to sea just 48 hours after arriving for repairs initially estimated to take two weeks, so Nimitz had three carriers to spearhead his counter-move.

The Japanese forces made their move in early June with heavy air attacks on Midway by aircraft launched from the carriers *Akagi*, *Kaga*, *Sōryū* and *Hiryū* early on the morning of June 4. When the planes returned to their carriers, the task group commander, Admiral Chūichi Nagumo, ordered them to be rapidly rearmed to continue the strikes. Just as this was underway, Japanese scout planes spotted the American carriers approaching from the east. Nagumo now ordered his planes be re-armed with torpedoes and armour piercing

bombs so they could strike the American ships. The delay meant the planes were not ready when the first wave of American aircraft from the USS *Enterprise* and USS *Hornet* arrived overhead. This first attack was driven off by Japanese anti-aircraft gunners and fighter planes but a second wave of American planes, including additional aircraft from USS *Yorktown*, then arrived.

American dive bombers hit the *Sōryū* and *Kaga*, with bombs penetrating their flight decks and exploding inside the hangars where the Japanese aircraft were still being re-armed. Bombs and torpedoes were stacked around the aircraft, causing massive explosions. Soon, more American aircraft found the *Akagi*, and she was also badly damaged.

Nagumo ordered aircraft from his surviving carrier, the *Hiryū*, to pursue the retreating US aircraft and strike at the American carriers. A wave of Japanese torpedo bombers struck the USS *Yorktown* and soon the carrier was listing badly.



During the afternoon of June 4, a new American attack found the *Hiryū*, and she was badly damaged. The carrier was soon ablaze but stayed afloat and was eventually abandoned by most of her crew. She sank a day later.

The American carrier task force commander, Rear Admiral Raymond Spruance, realised that he had achieved his objective by sinking the four Japanese carriers and decided to pull his fleet back to the east to protect it for future operations. Search aircraft were launched to try to find the remaining Japanese battleships and surface vessels, but they slipped the net.

Heroic efforts were underway to try to save the *Yorktown* and allow her to be towed back to Pearl Harbor for more repairs, but a Japanese submarine found the stricken carrier and put two torpedoes into her and sank an escorting destroyer. The carrier started to list heavily, and the damage control teams were evacuated overnight. On the morning of June 7, she rolled upside down and sank.

The sad end of the USS *Yorktown* notwithstanding, Nimitz and Spruance had won a great victory that changed the balance of naval power in the Pacific and opened the way for the offensive that eventually brought American forces to the coasts of Japan. This American victory was solely due to its superior use of carrier airpower - the age of the aircraft carrier as the dominant weapon in naval combat had arrived.

**ABOVE: SBD-3 Dauntless bombers of VS-8 overfly the burning Japanese cruiser *Mikuma* on June 6, 1942.**
(US NATIONAL ARCHIVES)

**LEFT: TBD-1 Devastators prepare to launch from the USS *Enterprise* at the height of the battle on June 4, 1942.**
(US NATIONAL ARCHIVES)

**BELOW: Japanese aircraft carrier *Hiryū* was badly damaged and later sunk, effectively marking the end of battle and Japan's ambitions to dominate the central region of the Pacific.**
(US NATIONAL ARCHIVES)

# The Gulf of Tonkin 1964-1973

## Striking from the Sea

**MAIN PICTURE:** A-4C Skyhawks of VA-146 over the USS *Kearsarge* off the coast of North Vietnam. The classic Skyhawk was in the forefront of early strikes against North Vietnam. (US NAVY)

**BELOW RIGHT:** US Navy carrier crews adopted the nickname the 'Tonkin Gulf Yacht Club' during the long Vietnam war. (US NAVY)

For just over nine years from April 1964 US Navy aircraft maintained a near continuous presence off the coast of Vietnam, launching daily air strikes across South East Asia.

The US naval aviators and sailors on the carriers were members of an exclusive group known as the 'Gulf of Tonkin Yacht Club'. They flew classic aircraft – the F-4 Phantom, A-4 Skyhawk, A-1 Skyraider, A-6 Intruder, A-7 Corsairs, F-8 Crusader and the mighty A-5 Vigilante – into action against what was then the most heavily defended airspace on the planet. The North Vietnamese had ringed their cities and strategic targets with thousands of anti-aircraft guns and Soviet supplied surface-to-air missiles, backed up by MiG-21 fighters, and were soon locked into daily duels with US air power.

The first carrier to fill Yankee Station, as the Gulf of Tonkin carrier operating zone was dubbed, was the USS *Kitty Hawk,* which was dispatched to the Gulf of Tonkin as a result of rising tension over Laos in the spring of 1964. The US and North Vietnam were backing rival sides in the country, despite international agreements that were supposed to secure its neutrality. Photographic reconnaissance jets from the USS *Kitty Hawk* started flying missions over Laos. This unofficial war escalated dramatically in August 1964 when there were reports of North Vietnamese patrol boats opening fire on US warships in the Gulf of Tonkin. US President Lyndon Johnson ordered US Navy jets off the USS *Ticonderoga* and USS *Constellation* to fly 64 strike missions into North Vietnam. Two US Navy aircraft were shot down and one pilot was taken prisoner.

By the spring of 1965, President Johnson had committed tens of thousands of US ground troops to South Vietnam and at the same time escalated the bombing of North Vietnam, under the code name Operation Rolling Thunder. This was an all out air offensive aimed at crippling the North Vietnamese strategic infrastructure – railway lines, power stations, oil refineries, ports, arms factories, ammunition dumps, truck parks and bridges -

**LEFT: The mighty A-6E Intruder received its combat début in Vietnam and remained on US Navy decks until the 1990s.** (US NAVY)

that allowed the communist state to support its forces fighting in the south. The US Air Force attacked from bases in Thailand and the US Navy struck from the Gulf of Tonkin. At the peak of Operation Rolling Thunder, between 1965 and 1968, there were usually three or four carriers filling Yankee Station, grouped under the command of Task Force 77.

The USAF and US Navy command divided North Vietnam into a series of zones dubbed Route Packs, with the navy having responsibility for hitting targets in coastal regions. Each carrier took turns to launch aircraft over the north to ensure there was a constant presence over enemy territory. When large or heavily defended targets needed to be attacked, then multiple carriers would launch a mass raid, dubbed an Alpla Strike, in a bid to overwhelm the defences.

In 1968, President Johnson ordered a pause in attacks on North Vietnam in a bid to kick-start peace talks. The Yankee Station carriers turned their attention to supporting US ground troops in the south as they gradually withdrew from the country over the next four years.

A major North Vietnamese ground offensive was launched into South Vietnam in the spring of 1972 and the new US President Richard Nixon ordered a massive build-up of US airpower to turn the back the Communist tide. Eventually, the USS *Kitty Hawk,* USS *Constellation,* USS *Midway,* USS *America,* USS *Saratoga,* USS *Coral Sea,* USS *Hancock* and USS *Oriskany* were all off the coast of Vietnam. The defeat of the North's offensive prompted the opening of peace talks in Paris but they hit a snag in December 1972 so President Nixon ordered a new round of heavy bombing focused on the communist

capital, Hanoi. The six carriers of Task Force 77 were in the thick of the action during the 11-day-long offensive, with their aircraft flying more than 500 sorties. Six US Navy aircraft were lost.

The last US Navy aircraft lost in combat over Vietnam was shot down on January 27, 1973 and two more naval aviators were briefly prisoners of war until the Paris peace accords came into effect to end the US combat involvement in South East Asia.

In the course of the war, 21 US aircraft carriers spent just over 9,000 days in total cruising on Yankee Station. Some 532 US Navy aircraft were lost in combat and 329 in accidents. Some 401 US Navy aircrew were lost, 64 reported missing in action and 179 ended up as prisoners of war.

**ABOVE: New jets such as the A-7E Corsair were on the decks of US Navy carriers when the war escalated again in 1972 and allowed targets such as the Hai Duong bridge to be attacked with a high degree of precision.** (US NAVY)

**LEFT: The Essex-class aircraft carrier USS *Bon Homme Richard* saw service in World War Two and the Korean war before making five operational cruises off North Vietnam. She was decommissioned in 1971.** (US NAVY)

**RIGHT: The Type 22 frigate HMS *Broadsword* alongside the task force flagship, HMS *Hermes*.** (ROYAL NAVY)

The 1982 conflict between Britain and Argentina over the Falkland Islands was the only occasion after World War Two when opposing aircraft carriers found themselves locked in combat on the high seas.

Argentine forces captured the disputed islands in a surprise assault on April 2, setting in chain a series of events leading Prime Minister Margaret Thatcher to order the dispatch of a naval task force, led by the carriers, HMS *Hermes* and *Invincible*, to retake the British territory.

As the Royal Navy task force approached the Falklands at the end of April 1982 to enforce a 200 mile maritime exclusion zone, the Argentine Navy put to sea to counter the British move.

Some 13,000 Argentine troops were garrisoning the Falklands and the British hoped to cut them off from their home bases by threatening to sink any ships that tried to enter the exclusion zone. HMS *Hermes* and *Invincible* launched their Sea Harrier FRS1 jets to attack Port Stanley airport in the early hours of May 1 in a bid to crater its runway and stop re-supply flights from the Argentine mainland. They hit the runway a few hours after a Royal Air Force Vulcan bomber had hit the same target.

This was the cue for the Argentine aircraft carrier, the ARA *Veinticinco de Mayo* to launch its own counter-attack. The carrier was probing along the northern edge of the exclusion zone later on May 1 and it launched an S-3 Tracker maritime patrol aircraft to try to find the British carriers so they could be attacked. Eight A-4 Skyhawks were armed and readied to launch from the carrier when the Trackers found their targets. Meanwhile, land-based Argentine air force aircraft were launched from their home bases against the British task force.

Royal Navy Harriers launched to intercept the attackers. Two Argentine air force aircraft were shot down in dogfights. On the ARA *Veinticinco de Mayo,* the Skyhawk pilots waited for the word to go but the S-3 Trackers couldn't locate the British ships. The carrier eventually turned for home to avoid detection by the British fleet.

The Argentine navy was justifiably fearful that its flagship would be detected and sunk by British nuclear attack submarines. On May 2, the Argentine navy's other major capital

**BELOW: Sea Harrier FRS.1 lifts off the from ski jump of HMS *Invincible*.** (ROYAL NAVY)

# The Falklands 1982

## The Last Aircraft Carrier Duel

ship, the ARA *General Belgrano,* was tracked and sunk by the submarine HMS *Conqueror* with the loss of 323 sailors. The ARA *Veinticinco de Mayo* turned for home and never again left Argentine territorial waters.

The British aircraft carriers were left free to protect the Royal Navy amphibious ships as they moved in to position to land Royal Marines on the Falklands. Argentine land-based aircraft were still a potent threat, particularly French-made Super Etendard jets armed with the Exocet sea-skimming missiles.

During daylight hours HMS *Hermes* and HMS *Invincible* launched their Sea Harriers to establish combat air patrols over the task force but there were not enough British jets to provide full coverage. An Etendard penetrated the combat air patrols on May 4 and fired two Exocets at the destroyer HMS *Sheffield*. She caught

fire and had to be abandoned with heavy loss of life.

A second Etendard attack with Exocets took place on May 25 in a bid to hit the HMS *Hermes* and HMS *Invincible* but the Argentine reconnaissance mistook a civilian container ship the MV *Atlantic Conveyor,* for one of the British carriers. The ship had been converted into an improvised flat top, carrying Harriers and helicopters to the South Atlantic to reinforce the task force. Her cargo of Harriers had already been flown off, but several helicopters were still being prepared for flight when she was hit by two Exocets.

The Argentine Navy made one last foray to fire its final Exocet on May 30, but the British had improved their defensive tactics, they were able to detect the in-bound missile and a frigate claimed it shot the weapon down. No ships were hit. With all their Exocets fired, there was now little the Argentines could do to resist the final British offensive that captured Port Stanley on June 14, thanks to the air support provided from HMS *Hermes* and HMS *Invincible*.

The battle for the Falklands remains the only conventional fleet-on-fleet naval engagement since World War Two. It showed that aircraft carriers were still potent platforms for projecting power, but it also confirmed that they were vulnerable to submarine and missile attack and needed to be protected. The innovative conversion of the MV *Atlantic Conveyor* into an improvised flat top also showed that aircraft carriers did not have to cost a fortune to build.

**ABOVE: HMS *Hermes* eventually embarked Royal Navy Sea Harrier fighters and Royal Air Force Harrier GR3 strike jump jets.** (ROYAL NAVY)

**MIDDLE LEFT: The Royal Navy was operating at the limit of its logistical support chain during the Falklands War.** (DEPARTMENT OF HISTORY, UNITED STATES MILITARY ACADEMY)

**LEFT: HMS *Sheffield* burns after being hit by an Argentine Exocet missile.** (ROYAL NAVY)

**ABOVE: US Navy F-14 Tomcats were at their operational peak during the 2001 Afghan war, flying strike, air supremacy and reconnaissance missions in support of US special forces teams on the ground.** (US DOD/COMBAT CAMERA)

On the morning of September 11, 2001, the clock started ticking on an American response to terror attacks on the US mainland. Hijacked airliners had been flown into the twin towers of New York's World Trade Center and the Pentagon and immediately the US looked to Osama Bin Laden and his supporters in Afghanistan as the antagonists.

For American military planners, Afghanistan was a very difficult target.

Afghanistan's land-locked location and the relative lack of bases in neighbouring countries meant the fastest way to get tactical airpower into play was from US Navy aircraft carriers, positioned in the North Arabian Sea off the coast of Pakistan. The nuclear-powered carriers USS *Enterprise*, USS *Carl Vinson* and USS *Theodore Roosevelt* were ordered to make best speed for the war zone, with more than 200 tactical combat aircraft.

During the build up to the conflict in the last two weeks of September 2001, US Navy Grumman F-14 Tomcats from the USS *Enterprise* flew reconnaissance missions over southern Afghanistan, taking high level images of airfields, surface-to-air missiles, anti-aircraft artillery sites, army barracks and training camps used by Bin Laden's Al Qaeda group.

In the early hours of October 7, a Tomahawk cruise missile strike was launched on Kabul and it was closely followed by a package of Tomcats and McDonnell Douglas F/A-18C Hornets from the USS *Carl Vinson*. The Hornets used AGM-84-ER Stand-off Land Attack Missiles to mount a precision strike on the remains of the Afghan air defence network around the capital. This was followed by a laser-guided bomb attack by Tomcats, who also bombed a barrack complex. The USS *Enterprise* launched a follow-up strike on Kabul's air defences later in the night.

Further south, Hornets from both the USS *Enterprise* and USS *Carl Vinson* pounded the airfield south of Kandahar city, hitting aircraft, SAM sites and radars. Nearby, a pair of

# Afghanistan 2001

## Aircraft Carriers Against Terror

**The USS *Theodore Roosevelt* was one of three aircraft carriers on station in the North Arabian Sea at the start of Operation Enduring Freedom.** (US DOD/COMBAT CAMERA)

Tomcats from the USS *Enterprise* were tasked to hit a suspected Al Qaeda cave complex with laser guided GBU-24 Paveway III penetrator bombs.

The long range of the Tomcats meant they were selected to join a strike by B-1Bs on Herat air base, near the Iranian border. Several MiG-21s were destroyed on the ground in the raid. Once the heavy bombers turned for home, the F-14s dropped laser guided bombs on a Taliban communications site at Farah.

During the first wave of strikes, the Central Intelligence Agency used a Predator unmanned aerial vehicle to monitor a group of suspected Taliban leaders leaving a compound in Kandahar and driving off in a convoy of vehicles. The Predator beamed video imagery back its headquarters in Virginia to allow a pair of US Navy Hornets to be directed to attack.

In the first five days of Operation Enduring Freedom, US Navy Hornets and Tomcats dropped 240 JDAMs, 1,000lb and 2,000lb laser guided bombs. The relatively modest amount of weaponry dropped illustrated the lack of large, fixed targets in Afghanistan and the difficulty of finding the elusive and fleeting high value targets linked to the leadership of Al Qaeda and the Taliban.

Towards the end of November, Taliban forces were on the run, with mass desertions and surrenders taking place to pro-US militia groups. Several hundred Taliban prisoners were corralled in the Qala-e-Jangi fortress outside Mazar-e-Sharif on November 25. The prisoners revolted and overpowered their guards, killing a CIA operative in the ensuing battle. US and British special forces teams arrived on the scene and began directing waves of US Navy jets and USAF AC-130 gunships to pound the escaped Taliban. It took several days for their resistance to be broken. Less than 100 Taliban fighters survived the battle, and 50 Northern Alliance soldiers were killed.

Two days later pro-US militia fighters and US special forces seized control of a provincial capital, Tarin Kwot in the south of Afghanistan. The Taliban assembled a large column of troops, pick-up trucks, and tanks in Kandahar to strike back at rebels. The US Green Berets and 50 militia fighters took up positions dominating the main road through a pass that the Taliban column would have to take. On November 17, the Taliban troops approached the first US position. US Marine Corps F/A-18C Hornets and US Navy F-14s attacked the Taliban column for three hours until they were in full retreat, leaving 30 destroyed vehicles and 300 dead behind.

The bulk of the offensive air operations were borne by US Navy and Marine Corps jets launched from the two carriers that were kept on station in the North Arabian Sea during this period. The US Navy and Marine Corps launched some 4,900 sorties, or 75% of all strike sorties flown, compared to 701 by USAF. Between October and December 2001, this broke down into 3,700 by F/A-18s, and 1,200 by F-14s.

**ABOVE: Laser guided bombs and other smart munitions allowed US Navy jets to hit targets with pinpoint accuracy across Afghanistan.** (US DOD/COMBAT CAMERA)

**LEFT: 'Nobody kicks ass without tanker gas' was the motto of US Air Force air-to-air refuelling squadrons supporting the US Navy strike jets heading into Afghan airspace.** (US DOD/COMBAT CAMERA)

**LEFT: Satellite guided Joint Direct Attack Munitions were used for the first time by the US Navy during the 2001 Afghan campaign.** (US DOD/COMBAT CAMERA)

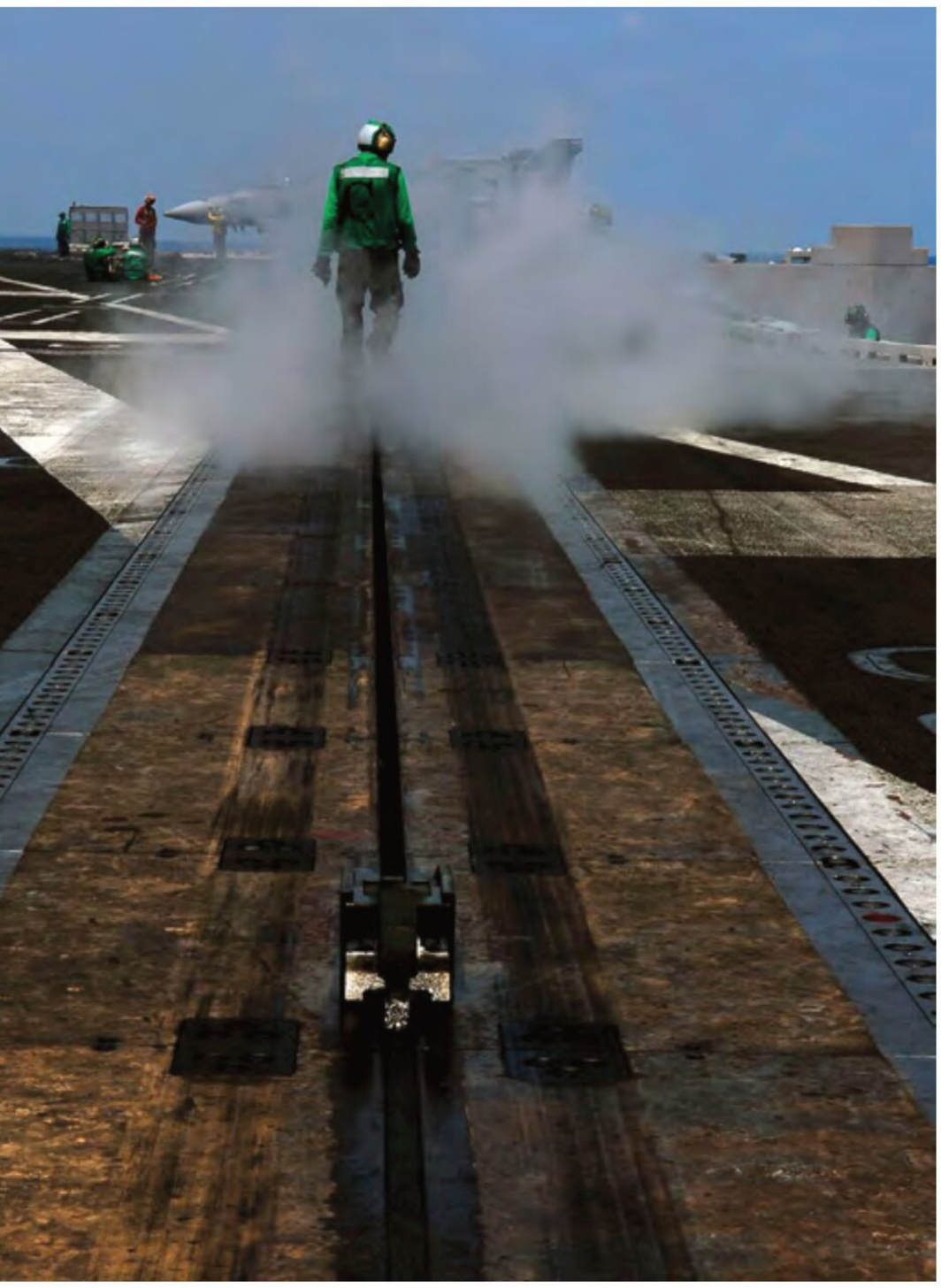
# How Aircraft Carriers Work

## Inside the Super Carriers

**BELOW: Getting jets in the air is the job of an aircraft carrier's flight deck crew.** (US NAVY)

Aircraft carriers exist to launch planes into the air. Since the days of flimsy bi-planes taking off from improvised platforms on the top of battleship gun turrets, the technology used in aircraft carriers has been transformed.

Now supersonic combat aircraft are routinely operated off aircraft carriers and doing this safely and efficiently requires a combination of advanced technologies, highly trained aircrew, ship-borne maintenance, and slick flight deck procedures. Bringing together these elements is a skill in itself and an inability to master them has prevented many navies from successfully fielding carrier-borne aviation capabilities. So, it is no surprise that only a few nations can afford to buy and operate aircraft carriers. »



**ABOVE: The steam catapult is at the heart of current US and French aircraft carriers.** (US NAVY)

**RIGHT: Landing signal officers have the job of guiding US Navy pilots down onto the decks of aircraft carriers.** (US NAVY)

The crucial ingredient is being able to package all the elements needed to operate carrier-borne aircraft in close proximity, both inside and on the flight deck of an aircraft carrier. Despite some super carriers being hundreds of metres long and coming in at 100,000 tons, there is never enough space on aircraft carriers and crews have to work hard to make things happen.

The most distinctive feature of aircraft carriers are their large flat flight decks, which are used to launch and recover aircraft. Getting the aircraft on deck and ready to go is a complex procedure and, not surprisingly, life on board carriers revolves around the daily flight schedule, either during live operations or routine training. The flight schedule lists the number and type of aircraft to be launched, as well as the timing of launches. This then determines when the aircraft will run out of fuel and have to return to the ship.

Armed with this crucial information, the flying squadrons will know when they have to have their aircraft ready, with crews briefed and maintenance personnel on hand to get them ready for flight. The ship's ordnance department will know what type of bombs and missiles to have ready to be loaded on the aircraft.

Up on the flight deck, the aircraft marshallers will be waiting for the aircraft to come up on lifts from the hangar deck and then position them in the right order on deck to be launched from the ship. This will have to done to a tight schedule so aircraft can be launched on time. Overseeing all this is a single officer, often known as the air boss, in a control room high on the island so he can see what is happening across the flight deck.

After aircraft have flown their missions, marshallers have to be on hand to rapidly move them off the deck or to parking spots. Keeping the flight deck clear of aircraft is essential to ensure that following aircraft can land safely.

While the daily flight schedule determines what many of the carrier's crew do, hundreds of other crew members are involved in keeping the aircraft and ship working smoothly. In the hangar deck, maintenance crews have to work around the clock to do routine checks between flights and longer term servicing of aircraft.

## The Unseen Tasks

Around the ship there are all the other sailors who have to keep the carrier in working order, including those in the engine room to keep the lights on and the propellers turning, on the bridge keeping the ship safe, in the medical facility looking after the crew's health, and in the galleys keeping everyone fed.

Everything about aircraft carriers is big. They have big engines, big fuel tanks, big nuclear reactors, and big mess decks. This means they have to have big crews to keep operating at maximum efficiency. Keeping an aircraft carrier's systems working can be very unglamorous work and the engine room staff or chefs will often not see outside their ship for many days at a time. During sustained flight operations, time for sailors to go up on deck or to the hangar can be reduced even more. The sailors who work on the lower decks of carriers often have no feeling for the movement of the ship. It can be a surreal experience for days that some compare to serving on a submarine.

**RIGHT: On US Navy aircraft carriers the air boss and his assistant, the mini boss, control all aspects of deck operations to ensure the flight programme is executed safely and efficiently.** (US NAVY)

Aircraft carriers, their aircraft and their crews consume vast amounts of supplies on a daily basis. This ranges across everything from fuel for the aircraft to food for the sailors and spare parts for the ship's equipment. Although nuclear-powered aircraft carriers do not need to refuel at sea, they need to refill their stocks of aviation fuel to keep their air group

flying. To keep this materiel flowing carriers are usually accompanied by supply ships and fuel tankers, which are equipped to pass supplies over to the carrier. This technique, known as replenishment at sea, involves the setting up of transfer lines between the carrier and the supply ship to move pallets across as the ships are underway. Pipes for fuel can also be passed across from fuel tankers to the carrier in the same way.

Aviators on amphibious warfare flat tops have to face very different challenges to their land-based colleagues. Amphibious assault air groups contain a high percentage of helicopters and combining the two types on a single flight deck is a very different skill from launching and recovering strike jets across a carrier deck.

Loading marines onto assault helicopters and delivering them to their objectives ashore requires very special techniques and procedures. Hundreds of marines will need to be mustered across their ships and then moved quickly onto flight decks with all their weapons and equipment. This must be choreographed with the launch schedule of the helicopters, to ensure they launch on time to fit into the battle plan. Follow-up waves of troops and supplies then have to be positioned to maintain the momentum of the operation. At the same time, waves of strike or attack jets need to be launched from the same deck and kept away from the troops and their transport helicopters.

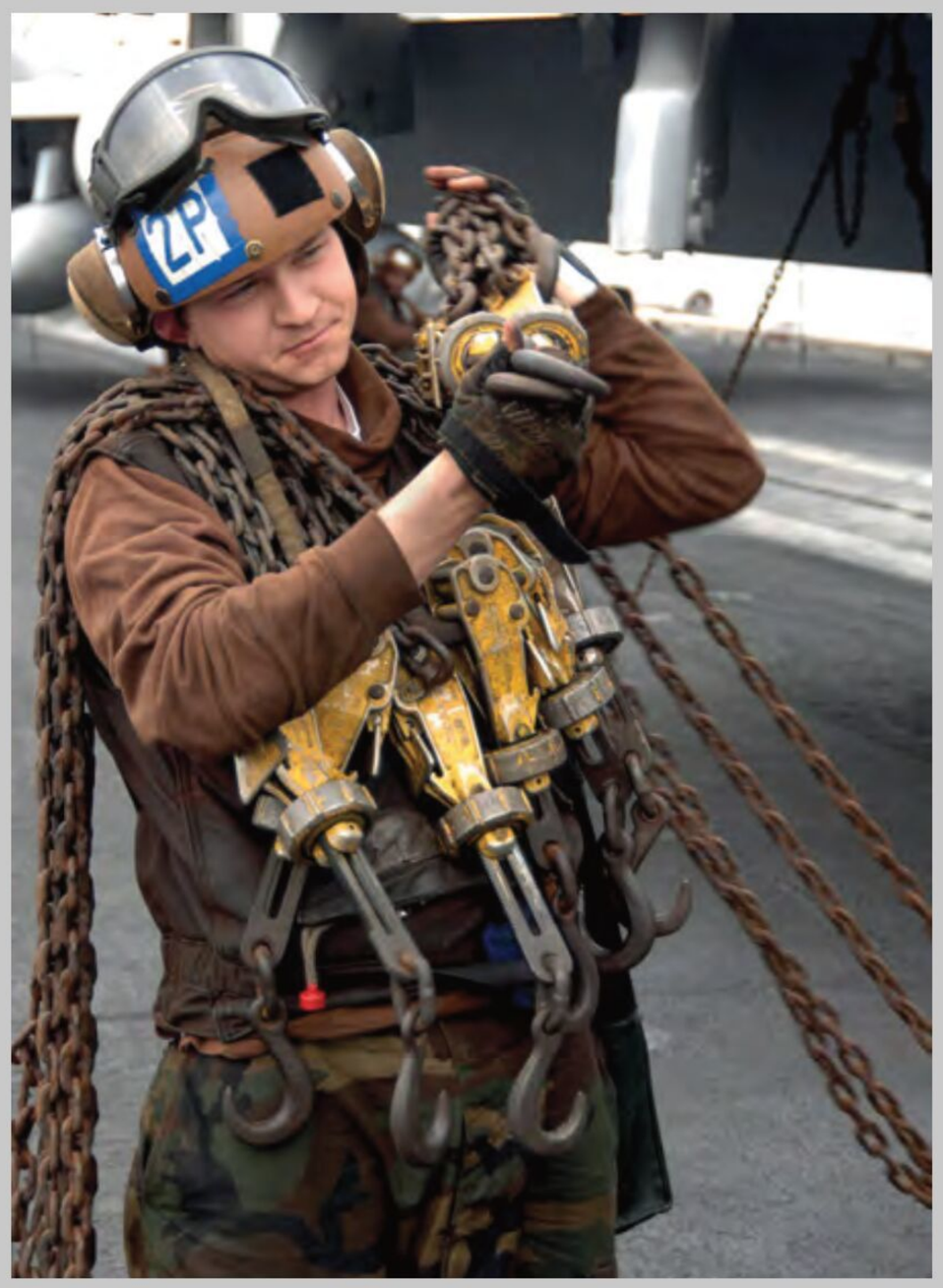
Although aircraft carriers possess tremendous strike power thanks to their aircraft, they are also very vulnerable if for any reason their aircraft cannot be airborne. So, aircraft carriers usually sail as part of a battle group, comprising air defence destroyers, anti-submarine frigates and attack submarines to monitor the underwater environment. These different types of warship help build a layered defence that can deal with multiple threats all around the aircraft carrier.

They also allow the carrier battle group to dominate thousands of square miles of sea and control huge expanses of airspace. Each of these escorts has multiple radar, optical and acoustic sensors that allow very detailed intelligence pictures of air, surface, and sub-surface activity to be built up.

To command these battle groups, navies usually place a senior admiral and a group of staff officers on board the aircraft carrier. This battlegroup staff is responsible for making sure all the components – aircraft, ships, and missiles – are working in concert as a coherent force.

Very few navies have the experience and expertise to build, operate and sustain a carrier battle group. Just putting an aircraft carrier to sea requires months of intense training and then combining a carrier into a battle group is an additional level of complexity. Only the United States Navy currently has the ability to put more than one carrier battle group to sea at a time. Other navies have to make do with occasional deployments of their carriers in between periods of maintenance and training.

The Chinese People's Liberation Army Navy and British Royal Navy both have ambitions to generate 24/7/365 carrier coverage by operating multiple carrier fleets, but they have yet to achieve their goals. It will be a long time before the US Navy's carrier dominance comes to an end.



**ABOVE: Working on the decks of aircraft carriers is hard physical work.** (US NAVY)

| US AIRCRAFT CARRIER CREW JACKET COLOURS AND TASKS | |
|---|---|
| COLOUR | TASK |
| YELLOW | AIRCRAFT HANDLING OFFICERS |
| GREEN | CATAPULT AND ARRESTING GEAR CREW |
| RED | ORDNANCE HANDLERS |
| PURPLE | AVIATION FUEL HANDLERS |
| BLUE | TRAINEE PLANE HANDLERS |
| BROWN | AIR WING PERSONNEL |
| WHITE | QUALITY/SAFETY/MEDICAL PERSONNEL |

**BELOW: Loading bombs and missiles on aircraft is the job of ordnance teams.** (US NAVY)

# How A Carrier Air Group Works

## Taking Air Power to Sea

**BELOW: Aircraft carriers are protected by a battle group of other warships providing layered defence against air, surface and undersea threats.** (MOD/ CROWN COPYRIGHT)

A carrier air group has to be 'an air force in a box'. To project power around the globe, aircraft carriers have to be able to sail into regions where it is not possible to call on support from land-based aircraft.

On these go-it-alone missions, carrier air groups need to be able to fly combat air patrols to protect their aircraft carrier and its battle group from air hostiles and missile attack. So, an essential component are top-of-the-range fighter aircraft, and they need to be backed up by airborne early warning aircraft to extend the range at which threats can be detected.

Offensive missions against land targets or enemy ships require strike aircraft that can successfully penetrate enemy air defences. The range of strike forces can be extended by air-to-air refuelling from other aircraft.

Specialist electronic warfare or suppression of enemy air defence capabilities can add to the all-round effectiveness of an air group, either in add-on capabilities for multi-role aircraft or in the shape of dedicated aircraft.

No air group is complete without helicopters that contribute in many ways. They provide essential rescue cover close to their carrier, standing ready to recover pilots from the sea who suffer mishaps during take off and landings. A more demanding task is combat search and rescue to recover downed aircrew from behind enemy lines, and that require helicopters and crews trained and equipped to penetrate enemy air space.

Another key job of helicopters is to contribute to anti-submarine operations to protect the ships in their carrier battle group. For navies that cannot afford large carriers capable of operating fixed wing airborne early warning aircraft, helicopters offer a cost effective way to elevate their surveillance radars to extend coverage.

Naval aviators have a unique *esprit de corps* that comes from flying aircraft in one of the most demanding environments in the world. Landing an aircraft on a moving carrier deck, often at night and in bad weather, tests pilots in a way that their shore-based counterparts can never experience. Being fired off a carrier's bow by a catapult is an experience that cannot be replicated, except perhaps in space travel.

**LEFT: Launching jets off aircraft carriers is only one key element of projecting airpower at sea.** (US NAVY)

**BELOW: Refuelling jets on the deck of an aircraft carrier has to be carefully controlled to minimise the risk of fire among jets loaded with bombs.** (US NAVY)

**BOTTOM LEFT: Embarked airpower has to be fully integrated into a full array of other capabilities to deliver decisive military effect.** (MOD/CROWN COPYRIGHT)

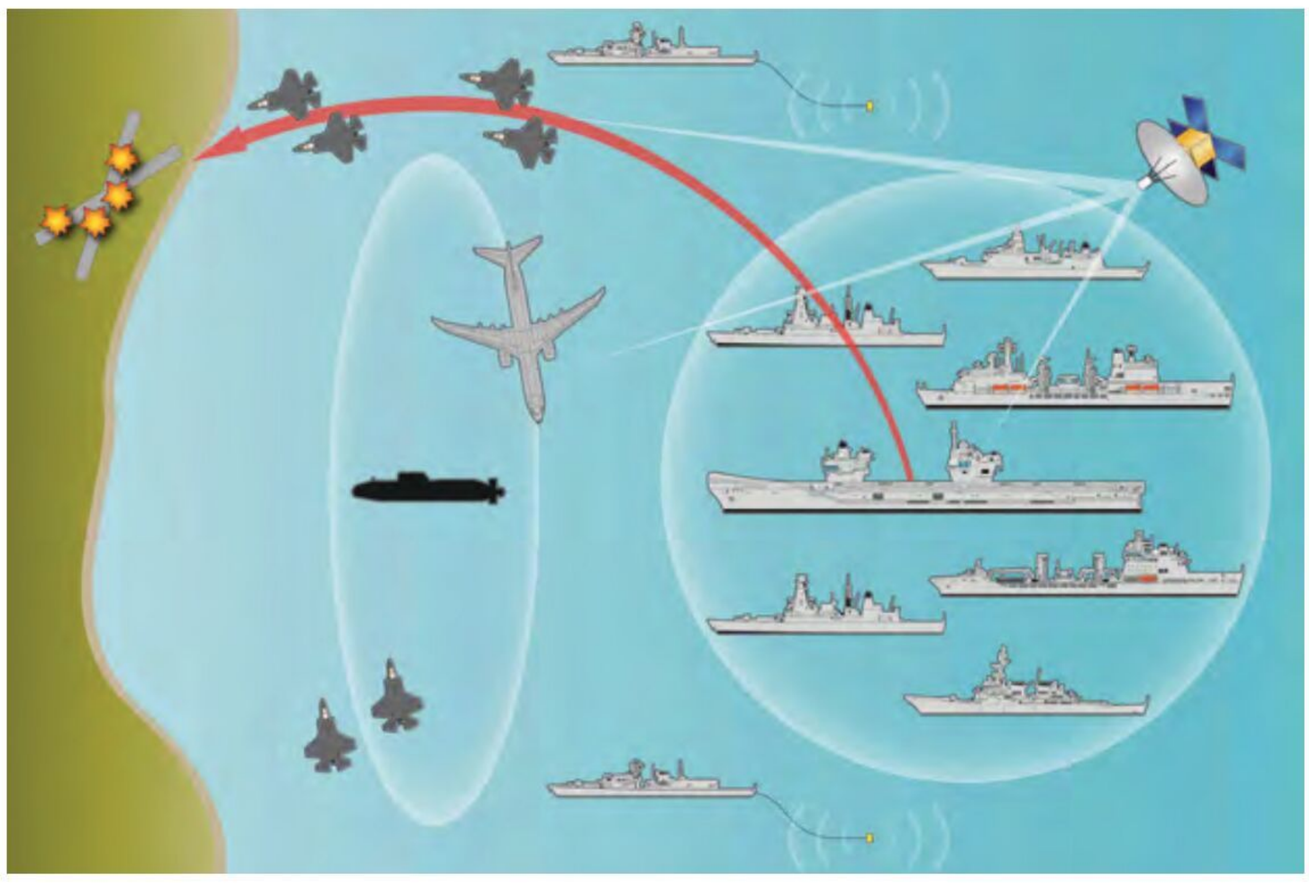
**BOTTOM RIGHT: Modern carrier air wings contain a mix of aircraft types to in effect create an 'air force in a box' for naval commanders.** (US NAVY)

Within an air group, each squadron has its distinctive character that comes from the type of aircraft or helicopter they fly. Fighter pilots may be top dogs because they fly at Mach 2 and look down on rest of the air group, but they need controllers on airborne early warning aircraft to guide them to their targets or rescue helicopter crews to pluck them out of the sea if they have to bail out. The heart of each squadron is their ready room where pre-flight briefings take place and crews hold social events to boost morale. As well as aircrew, naval aviation squadrons have their own maintenance personnel who keep their aircraft flying and accompany them on to deck prior to flight.

The commander of the air group, who is often nicknamed the CAG, is a key figure on an aircraft carrier. In the days of propeller aircraft during World War Two, US Navy CAGs led their pilots into battle and were often the first pilot to take off as waves of aircraft headed to their targets.

Today, the CAG has a more complex job. In the US Navy, for example, the CAG is the commander of an embarked air wing but does not report to the captain of its parent aircraft carrier. He is of equal rank and status as the carrier captain but reports directly to the commander of the carrier battle group. The CAG has a staff of a couple of dozen air warfare experts who have to plan and control all air operations across the battle group, including directing strikes by Tomahawk land attack missiles launched from warships and submarines.

Modern US Navy air wings are the biggest embarked aviation units in the world. They have four squadrons of E/F-18E/F Super Hornet multi-role strike jets, a squadron of EA-18G Growler jamming aircraft to confuse enemy air defences, and a squadron of E-2 Hawkeye airborne early warning aircraft to monitor airspace. They are supported by SH-60R Sea Hawk helicopters equipped to hunt submarines and SH-60S Sea Hawk utility helicopters that are available for combat search and rescue or just to move people and cargo around the battle group. To keep contact »



**ABOVE: Carrier air wings need to be self-contained in case their parent carriers are sent to operate in war zones out of range of land-based support aircraft, including their own organic air-to-air refuelling capability.** (US NAVY)

with shore bases, each US carrier has a detachment of C-2 Greyhound carrier onboard delivery (COD) aircraft. The US Navy is on the cusp of rolling out the deployment of the F-35C Lightning in its embarked carrier air wings to bring stealth or low observable capabilities into them for the first time.

In the British Royal Navy, the air groups on the Queen Elizabeth-class carriers are to be optimised for strike missions ashore and they are formally under the command of a theatre-wide or joint air component headquarters that could be on the ship or at a shore base. The joint air component commander is most likely to be a Royal Air Force officer who only communicates with the air group on the carrier by email or video-conferencing. The Royal Navy calls its embarked aviation unit, tailored air groups, and they are flexible organisations depending on the mission. For strike operations, one or two F-35B squadrons are to be embarked on its Queen Elizabeth-class carriers. All Royal Navy and Royal Air Force F-35Bs are under the command of Joint Force Lightning, based at RAF Marham in Suffolk. It currently has one frontline RAF unit - 617 'Dambusters' Squadron and an operational conversion unit, 207 Squadron. A second frontline F-38B unit, 809 Naval Air Squadron, is to be formed in 2023 when more aircraft are delivered. All units of Joint Force Lightning are manned jointly by RAF and RN personnel and officers of each service will take turns to command its squadrons.

When the Queen Elizabeth-class carriers are configured for amphibious operations, command of their tailored air group will fall to RAF, Army Air Corps or Commando Helicopter Force officers to control helicopter operations. RAF CH-47 Chinook, Royal Navy Merlin HC3 and Army Air Corps AH-64 Apache attack helicopters have all been approved to operate from the new carriers. For marine operations, Fleet Air Arm Merlin HMA2 and Wildcat HMA2 helicopters can be embarked. These helicopters can hunt submarines or strike at enemy ships.

The US Marine Corps has its own air group concept that is optimised to support amphibious operations. All its deployed forces are combined into all-arms Marine Air-Ground Task Forces with air units, ground, and amphibious ships working under a single commander. In Marine Expeditionary Units (Special Operations Capable), there is a battalion-landing team of marines and an air combat element based around US Marine Corps Tilt Rotor

**RIGHT: C-2 Greyhound carrier-on-board aircraft provide the logistic link to US Navy aircraft carriers far out at sea.** (US NAVY)

Squadron equipped with the MV-22B Osprey tilt rotor aircraft. This squadron has detachments of AV-8B Harriers or F-35B Lightning jump jets, CH-53E/K heavy lift helicopters, AH-1W Cobra gunships and UH-1Y utility helicopters.

Other navies that operate aircraft carriers all configure their air groups in similar ways to the US Navy and the Royal Navy, although often on a smaller scale because of the size of their carriers. This brings many unique challenges.

The French Naval Aviation service, or *Aéronavale,* is the only other naval air arm that operates catapult-capable aircraft in the shape of the Rafale and the E-2 Hawkeye. This means that French and US carrier air groups are able to share aircraft and operate from each other's ships.

Russian, Indian, and Chinese air groups are based around modified land-based supersonic fighter jets which makes them some of the most potent carrier-borne aircraft. Operating these powerful and large aircraft from ships is a very demanding skill and these naval air arms have suffered disproportionate accident rates.

The Italian Navy has ordered the F-35B to replace its aging AV-8B Harriers and Japan has also decided to purchase the jump jet to operate from its new flat top. Spain is considering following with an order for a small number of F-35Bs to replace its AV-8Bs. South Korea is also looking to buy the jets for its new amphibious warfare ship.

That many new types of carrier-borne aircraft continue to be fielded across the world is a testimony to the enduring power and flexibility of naval aviation. These new aircraft still have to meet the demanding requirements of sustained operations at sea – there is no room for second best on the deck of an aircraft carrier.

**TOP:** **Helicopters provide carrier battle groups with protection against surface and underwater threats, logistic support and if needed they can help rescue downed aviators.** (US NAVY)

**ABOVE:** **The era of the F-35 Lightning is arriving as more and more navies transition to the new jet.** (MOD/CROWN COPYRIGHT)

**LEFT:** **F/A-18 Super Hornets are at the heart of US Navy air wings.** (US NAVY)

# AV-8B Harrier

## The Classic Jump Jet

**MAIN PICTURE:** The US Marine Corps remains the largest user of the classic AV-8B Harrier. (US NAVY)

**RIGHT:** Italy's navy still uses the two-seat TAV-8B Harrier trainer to prepare its pilots to operate off its aircraft carriers. (US NAVY)

The AV-8B was the definitive version of the classic Harrier design. It remains in service with the US Marine Corps, as well as the Italian and Spanish naval air arms, although in diminishing numbers. The two-seat variant is the TAV-8B.

In the 1970s the USMC started to look to improve their classic AV-8As by installing an improved engine and major structural enhancements. It was soon dubbed the Harrier II. The UK joined the programme, and its aircraft were dubbed the GR5/7/9. The Royal Air Force and Fleet Air Arm retired their Harriers in 2010 and the surplus airframes and spares pool were sold to the USMC to help keep their aircraft flying.

USMC Harriers have been progressively upgraded including fielding the AN/APG-65 multimode radar, Litening targeting pod to allow precision guided munitions to be used, and the integration of a helmet mounted sight. A wide array of weapons has been fielded on the aircraft, including GPS guided Joint Direct Attack Munitions (JDAM).

The USMC used the aircraft in combat in the 1991 and 2003 Iraq wars, in Kosovo and Afghanistan, as well as in the Libyan and Syrian conflicts. Detachments of five AV-8Bs are routinely deployed on US Navy amphibious warfare ships as part of Marine Expeditionary Units. Progress is well underway to re-equip all the USMC's fighter attack squadrons with the F-35B Lightning jump jet and it is intended that this process will be complete by 2028 to allow the AV-8B to be retired. Out of just over 270 ordered by the USMC, less than 80 remain in service.

Italy has also ordered the F-35B to replace its 18 AV-8Bs and Spain has started the process of replacing its 19 Harriers with the new jump jet.

# E-2 Hawkeye

## The Eyes and Ears of the Fleet

The E-2 Hawkeye has been the US Navy's main airborne early warning aircraft since the 1960s and it is expected to continue in service for decades to come as a result of continuous upgrade programmes.

Hawkeyes are an essential element of US carrier air groups, allowing radars to be elevated to high altitudes so they can 'see' around the curvature of the earth to provide earlier warning of approaching threats.

The first Hawkeye flew in 1960 and entered US Navy service in 1964. They went to sea for the first time in 1965 and since then every carrier air group has gone to sea with a squadron of four aircraft. Its airframe was subsequently modified for the US Navy by removing its radar to become the C-2 Greyhound 'carrier on-board delivery' or COD aircraft.

Over the past 54 years the US Navy has consistently invested in improving the E-2 and several variants have existed. The second variant, the E-2B, featured improved computers.

The most numerous version the E-2C, was introduced in 1972 with the last batch being built in 1991. The E-2Cs have in turn been progressively improved by fitting new radars, mission computers, engines, propellers, electronic warfare systems and network communications. These variants were designated Group 0, Group 1, Group 2, Group 2 Plus and Hawkeye 2000, and the US Navy progressively updated its aircraft to the newer standards.

The latest version, the E-2D, is under development and the US Navy plans to upgrade its aircraft to this standard over the coming decade. It features new avionics, enhanced engines, a new glass cockpit and air-to-air refuelling.

France's Aéronavale is the only other operator of the aircraft that embarks them on aircraft carriers. US and French E-2 squadrons have each operated from the other's aircraft carriers.

**ABOVE: The E-2 Hawkeye has been the US Navy's primary carrier-embarked airborne early warning aircraft since the 1960s.** (US NAVY)

**BELOW LEFT: Continuous modernisation has meant the modern E-2 Hawkeye is far more capable than its earlier variants.** (US NAVY)

# F/A-18 Super Hornet

## Wings of the Fleet

**ABOVE: The F/A-18F is the two-seat variant of the Super Hornet and each US Navy carrier air wing usually goes to sea with one squadron of these jets.** (US NAVY)

In the early 1990s the US Navy sought to rationalise its fast jet inventory around a modernised version of the veteran F/A-18 Hornet. Concerned about rising costs of operating air wings comprising different types of fighter (F-14 Tomcat), strike/tanker (A-6 and F/A-18A/B/C/D) and electronic warfare (EA-6) aircraft, the US Navy launched the Super Hornet programme. This was not meant to be a 'big bang' programme to field a new airframe but a cost effective effort to incorporate product enhancements, improved manufacturing, and economies of scale to reduce the cost of operating fast jets at sea.

The result was the E/F-18 Super Hornet. It was not universally welcomed by naval aviators because it followed on the from the cancellation of a purpose-designed naval air superiority fighter, which was billed as the US Navy's equivalent of the USAF's F-22 Raptor. With the demise of the Soviet Union and the lack of a credible peer opponent in the 1990s, the US Navy was more worried that carrier aviation was just becoming unaffordable.

From a distance it is very difficult to differentiate between a legacy Hornet and the Super Hornet, but they are very different aircraft, and the new version is 20% larger. These improvements mean it has 33% more internal fuel, resulting in a 41% increase in mission range and 50% enhancement of endurance compared to the classic Hornet. This added weight meant the aircraft's undercarriage and arrestor hook system had to be strengthened.

To reduce the Super Hornet's radar signature its air intakes were redesigned to partially conceal the aircraft's engine blades. Other stealth or low observable features were incorporated into the airframe, including the alignment of fuselage and wing panels to reduce radar reflections.

One of the biggest enhancements was the installation of AN/APG-79 active electronically scanned array radar. This radar replaced the mechanically rotating antenna used in the legacy Hornet. The new radar took time to develop and was not ready in time for first deliveries of the Super Hornet but has since been retrofitted to early production aircraft.

The Super Hornet has been fielded in three main variants:

- E/F-18E is the main single seater
- E/F/-18F is the two seater
- E/F-18G Growler is the dedicated electronic warfare variant.

The first two variants are fielded by US Navy strike attack squadrons and the Growlers are used by US Navy electronic attack or jamming squadrons.

The Growler has 90% commonality with E/F but has improved wing leading-edge fairings and wing fold hinge fairings and added wing fences and aileron 'tripper strips'. It has electronic warfare systems installed into the fuselage and can also carry additional jamming pods to interrupt enemy radar transmissions and radio communications, as well as the AGM-88 HARM missiles that can be guided towards enemy radars. The first Growlers were accepted into US Navy service in 2008 and some 150 had been delivered by 2019.

The US Navy had taken delivery of 322 one-seater F/A-18Es and 286 two-seated F/A-18Fs by 2019, with some 72 Block III variant Super Hornet aircraft being built out to 2021. There are plans to build more out to 2024 but funding has yet to be confirmed.

Since the first F/A-18E/Fs formally entered US Navy service in 1999, a gradual process has been underway to retire the legacy C/D model Hornets. The legacy C/D Hornets are still service in US Marine Corps embarked carrier strike attack squadrons as the service did not opt to buy the F/A-18E/F, preferring to skip a generation of aircraft to replace its legacy Hornets with the F-35C.

The last C/D model was retired from frontline service with the US Navy in 2019. Until the first F-35Cs come online the Super Hornet will be the sole fast jet fighter in US Navy carrier air wings.

**ABOVE:** **Providing air support to coalition ground troops in Afghanistan has been a core mission for the US Navy F/A-18E/F Super Hornet squadrons.** (US NAVY)

**LEFT:** **The F/A-18E/F Super Hornet boasts an impressive array of precision guided munitions.** (US NAVY)

**BELOW:** **The Super Hornet is set to remain in service with the US Navy for at least two more decades.** (US NAVY)

# F-35B Lightning

## A Jump Jet for the 21st Century

**ABOVE: HMS *Queen Elizabeth's* air group is built around the F-35B Lightning.** (MOD/CROWN COPYRIGHT)

**BELOW RIGHT: The F-35B Lightning is the only in-production vertical take-off and landing combat aircraft in the world.** (MOD/CROWN COPYRIGHT)

The F-35B Lighting is the vertical take-off and landing (VTOL) variant of the international Joint Strike Fighter (JSF). It is fitted with a revolutionary lift fan and rotating jet nozzle to control final stages of landing and take-off.

The United States Marine Corps and the UK were the prime drivers of the variant, with the intention of building a replacement for the stalwart AV-8B Harrier family of jump jets. Under existing plans, the USMC intends to purchase 353 aircraft and the UK has 48 on contract to equip the air wings of the two Queen Elizabeth-class carriers.

In addition, the Italian military has ordered 15 to be embarked on the country's aircraft carriers. Japan, South Korea, and Spain are all in advanced stages of buying the aircraft, which is the only in-production VTOL aircraft in the world. Italy and Spain aim to replace their AV-8Bs, while the Japanese and South Koreans will be fielding a new embarked aviation capability when they receive their aircraft.

For operators, the F-35B will bring both the VTOL capabilities of the old Harrier as well as the stealth or low observable capabilities of Fifth Generation combat aircraft. When flying in full-on stealth mode, all weapons are carried in the internal weapons bay. For missions that do not require stealth flight profiles, the aircraft has several wing pylons to carry additional ordnance.

The lift fan and rotating nozzle have very different properties from the Harrier's four rotating jet nozzles, so aircraft carrier decks and runways need to be protected with special heat resistant coatings.

USMC F-35B squadrons have dropped live weapons from the aircraft during missions over Iraq and Afghanistan. UK F-35Bs have also flown operational mission over Iraq and Syria but have not released live ordnance.

# F-35C Lightning

## The First Carrier-borne Stealth Fighter

US Navy carrier air wings will start to go to sea with the F-35C Lightning in 2021 as part of a phased introduction to frontline service of the first carrier-borne stealth fighter.

While the navy variant of the Joint Strike Fighter (JSF) looks externally very similar to the US Air Force F-35A and the US Marine Corps F-35B, the F-35C has some important differences.

The rear fuselage has been modified to incorporate an arrestor hook and the twin nose wheel can be attached to aircraft carrier catapults. Compared to the basic F-35A, the US Navy variant has larger wings to improve handling at slow speeds during final approaches to carriers and to allow extra fuel to be carried. There are also folding wing tips so the jet can be moved off deck on the lifts of US Navy carriers. The additional fuel means the F-35C has 300 nautical miles additional range compared to the USMC's F-35B.

Although the UK briefly toyed with ordering the F-35C between 2010 and 2012 for use on its Queen Elizabeth–class carriers, technical problems with the experimental electro-magnetic catapults meant that the UK reverted to the F-35B. This left the US Navy and the USMC as the only customers for the F-35C, with the US Navy ordering 257 aircraft and the USMC 67 of the variant. The aircraft will equip navy strike squadrons and four marine fighter attack squadrons, which are to routinely deploy on navy carriers.

The US Navy is coming late to the JSF and only declared initial operating capability in February 2019. The service has yet to deploy a squadron at sea as part of routine carrier air wing deployments. The USS *Carl Vinson* is expected to go sea with an F-35C squadron in 2021. The ambition is that by the end of the 2030s each US carrier will go to sea with two F-35C squadrons and two F/A-18E/F Hornet squadrons embarked.

**ABOVE: The F-35C boasts a bigger wing to improve its combat performance and low speed handling.** (US NAVY)

**ABOVE: US Navy carrier air wings are starting to go sea with the catapult-launched version of the Lightning, the F-35C.** (US NAVY)

# J-15 and J-31

## Dragons over the Sea

**ABOVE:** Work is underway to develop a carrier-borne variant of the J-31 stealth fighter. (DEFENCE PICTURE LIBRARY)

**BELOW:** The domestically built J-15 is the core of the People's Liberation Army Navy's carrier-borne aviation. (PLAN)

Hand-in-hand with the ambitious plans of the People's Liberation Army Navy (PLAN) to build its fleet of aircraft carriers, the Chinese government has set in train several projects to build carrier-capable fixed wing aircraft.

Unlike the Indians who decided to buy Russian aircraft to equip their former Soviet aircraft carrier, the Chinese opted to build their own carrier aircraft. The Russians had hoped to sell a carrier-capable derivative of the Su-27 Flanker super fighter to China, the Su-33, but the PLAN opted to build their own naval derivative of the J-11, which was the Chinese manufactured Su-27 version. The Ukrainians sold the Chinese an Su-33 which allowed them to reverse engineer some of the carrier-specific features, such as the folding wing system, arrestor hook and enhanced lift wing. Anti-ship missiles and other precision guided weapons have been integrated into the J-15 to give it a multi-role capability, although the range and payload the jets can carry is limited by the lack of catapults and use of ski jumps.

The first J-15 flew in 2009 and the aircraft made its first landing on the PLANS *Liaoning* in September 2012. Around 50 aircraft have been manufactured to date to operate from the first two Chinese carriers. More are expected to be ordered to operate from the future Type 003 carrier.

Also, a catapult-capable variant of the Chinese J-31 stealth fighter is reportedly under development to operate from the Type 003 carrier when she enters service later in the decade.

To provide this new super carrier with its own organic airborne early warning capability, the PLAN has begun developing the KJ-600 airborne early warning and control aircraft. Images of the aircraft under test suggest it is similar in configuration to the US E-2 Hawkeye aircraft.

Beyond its next generation fighters, the PLAN has also reportedly been investigating fielding stealth attack drones on the Type 003 carrier.

# Ka-31

## Russia's AEW Helicopter

Russian, Indian, and Chinese naval forces are protected by the Ka-31, which has the NATO code-name Helix. Its origins lie in a Soviet programme in the 1980s to field large new aircraft carriers to provide air cover for Moscow's fleet.

The Soviet navy's classic Ka-27 anti-submarine helicopter, which has its distinctive twin counter-rotating blades and bedstead under-carriage, was selected to be the platform for the new system, which used an E-801M OKO or 'Eye' electronic array radar. At the time this was revolutionary technology and other navies have incorporated that same technology into their airborne early warning systems. The helicopter is highly automated with the two flight deck crew operating the whole system from a bank of multi-function displays.

The radar is installed under the fuselage of the helicopter and folds up for landing. It has a range of some 150 kilometres against air targets and 200 kilometres against ship targets. The helicopter also has a fully digital datalink to allow surveillance data to be downloaded to warships or ground control centres up to 400 kilometres away.

A prototype began flying in 1987 but the collapse of the Soviet Union delayed the programme and the first helicopters only went to sea on *Admiral Kuznetsov* in 1995. The Russian navy now routinely embarks its Ka-31s on its carrier, other warships, and land bases to provide airborne early warning over its fleet. Deliveries to the Russian navy have been slow with only three confirmed as in service by 2020.

The Indian Navy ordered 14 of the helicopters in 2002 for service on board the INS *Vikramaditya* and a decade later the Chinese Liberation Army Navy ordered nine.

**ABOVE: Airborne early warning for Russian, Chinese, and Indian aircraft carriers is provided by the Ka-31 helicopter.** (RUSSIAN NAVY)

# AgustaWestland Merlin AEW

## Protecting Europe's Carriers

**ABOVE:** The Crowsnest variant of the Merlin HMA2 maritime helicopter is to provide airborne early warning for HMS *Queen Elizabeth* and other Royal Navy warships. (LOCKHEED MARTIN)

**BELOW RIGHT:** Italy has its own dedicated airborne early warning version of the Merlin helicopter to protect its aircraft carrier. (LEONARDO)

The British and Italian navies have both fielded airborne early warning helicopters, based on the Merlin design, for use on their aircraft carriers.

Britain's Royal Navy has operated airborne early warning helicopters since 1982 when they were rushed into service to protect the task force sent to the Falkland Islands from Argentine Exocet missile attack. In an urgent project, the Searchwater radars were fitted on the side of a Sea King helicopter, inside an inflatable bag.

In the 1990s, a new version was fielded with an improved Searchwater 2000AEW radar and mission system, that also had the capability to track over-land targets.

As the Sea King approached retirement with the Royal Navy, the service began planning migration of the Searchwater 2000AEW onto a Merlin. The project was dubbed Crowsnest, and it was intended to be ready in time to enter service as HMS *Queen Elizabeth* was to be declared operational in 2021. The project has since hit technical delays and it has not yet been declared fully operational but a pair of Crowsnest helicopters will deploy on the carrier in 2021 as part of the trials to prepare the helicopters to enter service.

Unlike with the old Sea King, the Crowsnest equipped helicopters are not operated by a dedicated squadron. The new aircraft are to be incorporated in anti-submarine Merlin squadrons to create multi-role units.

The Italian navy was the first to install a radar on a Merlin and unveiled the EH101 Heliborne Early Warning (HEW) configuration in 2003. It bought four of the helicopters fitted with Eliradar APS-784 radars, mounted in a radome under the forward fuselage. These helicopters have since operated from aircraft carriers and from shore bases to protect the Italian fleet.

# Mikoyan Mig-29K

## Russia's Multi-Role Naval Fighter

The carrier-borne version of the MiG-29, or Fulcrum as it was known to NATO, can trace its roots back to the 1980s when the Soviet Navy wanted to field a mixed force of MiG-29s and Su-33s on the decks of new classes of large aircraft carriers.

When the Soviet Union collapsed, the new Russian navy had to dramatically cut back its ambitions to field four aircraft carriers and consequently there was less need for jets to go on them. This meant there was no longer a requirement for two types of carrier jet, so the decision was made to concentrate on the Su-33 and the MiG-29K never went into production for the Russian Navy.

Fast forward to 2004 and after the Indian Navy decided to buy the ex-Soviet carrier, the *Admiral Gorshkov*, the Russian aerospace industry re-opened the MiG-29K project as a private venture to equip the new Indian vessel, which was soon titled the INS *Vikramaditya*. The new K version included arrestor hook and landing-gear enhancements, as well as fuselage strengthening, a new radar, engines, digital avionics, and the capability to employ modern 'smart' weapons. A two-seat variant was also built to allow pilot training to take place. India eventually ordered 45 of the aircraft.

In 2009 and having witnessed the effectiveness of the Indian MiG-29Ks, the Russian Navy decided to buy a batch of the new aircraft to replace the 1980s-vintage Su-33s. By 2016 all 24 aircraft had been delivered and the first examples took part in the Syrian campaign, flying from the *Admiral Kuznetsov*. One aircraft was lost during the campaign after an arrestor hook problem prevented the jet landing back on the carrier.

**ABOVE: Indian was the launch customer for the MiG-29K to equip its latest carrier, the INS *Vikramaditya*.** (INDIAN NAVY)

**LEFT: A key feature of the MiG-29K is folding wings which allow the jet to be stowed below deck inside aircraft carrier hangers.** (ALAN WILSON)

# Rafale

## France's Carrier Fighter

**ABOVE: France's multi-role Rafale fighter is able to operate from US Navy aircraft carriers, such as the USS *Theodore Roosevelt*, because they are designed to be interoperable with US catapult systems.** (US NAVY)

**BELOW RIGHT: Rafale fighters served alongside Super Étendard and E-2 Hawkeye aircraft in the FS *Charles de Gaulle's* air group until 2016.** (AURORE DEFFERRIERE)

The Rafale M is the naval version of the primary French military jet combat aircraft. It has its origins in the 1970s when the French Ministry of Defence asked the Dassault aircraft company to develop a single aircraft to replace several in-service jets, including the Mirage 2000, Mirage F1 and Super Étendard.

The result was the Rafale, which was intended to replace the Super Étendard as the *Aéronavale's* main fighter. Unlike the Super Étendard, which was optimised for air-to-ground or anti-ship missions, the new Rafale M was a true multi-role aircraft capable of employing modern beyond-visual-range, air-to-air missiles, including the MICA and Meteor weapons. ASMP-A nuclear-armed cruise missiles can also be launched by the Rafale M.

Two Rafale Ms were delivered to the *Aéronavale* in 2000 for trials and the aircraft was declared operational in 2004. During the first decade of its service, the Rafale M was employed predominately in the air-to-air and escort roles, supporting offensive strikes by Super Étendards. By 2016, the Rafale Ms air-to-ground capability was fully online, allowing the Super Étendard to be retired. That same year, Rafale M strike missions were launched from the FS *Charles de Gaulle* against Islamic State targets in Syria and Iraq. In 2018 a dozen Rafale Ms embarked on the USS *George HW Bush* in an inter-operability exercise.

Just under 50 out of an order for 60 aircraft have been delivered to the *Aéronavale* and it is expected that the order will be complete by 2024. Three frontline squadrons operate the jet, with one routinely embarked on the FS *Charles de Gaulle*.

When the UK was considering installing catapults on its Queen Elizabeth-class carriers, Dassault briefly offered the Rafale in competition to the F-35C and the F/A-18E/F Super Hornet but nothing came of the pitch when the UK dropped the idea. France has also offered the Rafale to India for its future multi-role carrier-borne fighter requirement. No decision has been made on moving forward with this procurement.

# Sukhoi SU-33

## Russia's Naval Top Gun

In the late 1970s, the Soviet Naval Aviation branch commissioned the development of a carrier version of the Su-27, or Flanker as it was known to NATO, after it became clear that their Yak-130 jump jet was not a match for US and NATO carrier –borne jets.

The Sukhoi Design Bureau produced the Su-33 which incorporated several new features to make the aircraft more suitable for carrier operations, including folding wings, arrestor hook, reinforced undercarriage, and enhanced wing shape to improve lift.

During the 1980s the Soviet Navy was preparing to field a fleet of three 46,000 ton Admiral Kuznetsov-class fast jet carriers and then add a 75,000 ton Ulyanovsk-class mega carrier in the 1990s. At least 72 of the Su-33s were envisaged as being needed to equip these new flat tops.

The collapse of the Soviet Union put paid to these plans and only the *Admiral Kuznetsov* ended up being completed for the new Russian Navy. So, the order of Su-33s, was cut to just 24 jets and they went to sea on the carrier when she started her operational deployments in the mid-1990s.

Improvements were ordered to the jets after the turn of the century to allow them to remain in service, including adding a precision bombing system to improve its air-to-ground strike capabilities.

This system was ready in time for the *Admiral Kuznetsov* to sail to the Mediterranean in October 2016 so her aircraft could join the Russian bombing campaign in Syria. Su-33s from the carrier became the first Russian, or Soviet, carrier-borne aircraft to participate in live combat operations. One jet was lost in a landing incident during the Syria mission.

It had been envisaged that the Su-33 would be phased out in favour of the more modern MiG-29K, but the Russian Navy has since decided to keep both types of jet in service.

**ABOVE: Su-33s first flew combat missions from the RFS *Admiral Kuznetsov* over Syria in 2016.** (US NAVY)

**BELOW: The mainstay of Russian carrier aviation for three decades has been the Su-33.** (DMITRY TEREKHOV)

# Plans *Liaoning* (16)

## Conventionally Powered Aircraft Carrier

**MAIN PICTURE:** China's first ever aircraft carrier, the PLANS *Liaoning*, is a former Soviet vessel that has been extensively modernised and upgraded. (BAYCREST)

China's first aircraft carrier has a very convoluted history, dating back to the final days of the Soviet Union in the 1980s.

The Chinese Type 001 aircraft carrier, PLANS *Liaoning* , started her life in 1985 in a Soviet shipyard at Nikolayev in what is now independent Ukraine. Initially named *Riga* after the Latvian capital, the Kuznetsov-class carrier was almost complete when the Soviet Union collapsed in 1991 and Ukraine broke away from Moscow. Already the Soviet Navy had re-named her the *Varyag* following Latvia's declaration of independence.

In 1992, the Ukrainians put the ship up for sale but there were no takers despite expressions of interest from Russia, India, and China. The Kiev government put little effort into selling the ship and she languished at the Nikolayev yard for another six years until a buyer was found.

There then followed a bizarre series of events that eventually led to the ship ending up in China. In 1998 a Macau-based company bought the rusting hull at auction for US$20 million, allegedly for her to be converted into a floating hotel and casino. Other former Soviet warships had ended up as Chinese tourist attractions, so this did not initially raise any suspicions.

The ship then began an extraordinary tow to China. First, the Turkish government refused to allow her through the Bosporus, citing a prohibition under the Montreux convention regarding the passage of warships through the Bosporus and Dardanelles straits. For several months she remained under tow in the Black Sea until the Chinese government intervened to persuade the Turks to let her pass. This was the first hint that she might end up in the service of the People's Liberation Army Navy (PLAN). Then the

Egyptians banned her from using the Suez Canal because vessels have to use their own power to navigate the waterway. So, she had to be towed all the way through the Mediterranean and then around the Cape of Good Hope at the bottom of Africa in to the Indian Ocean. On one occasion the ship broke free from her tow, killing a crew member. The ship eventually arrived in Chinese waters in March 2002 and was then moved into the Dalian Shipyard in northeast China to begin an extensive overhaul. It soon became clear that the PLAN intended to bring her into service as the country's first aircraft carrier.

In the shipyard, the ship was taken out of the water and her hull sandblasted to begin the process of returning her to service. Scaffolding soon surrounded the hull as Soviet-era weapons and systems were removed and modern Chinese equipment was fitted, including new radars, communications systems,

and air defence missiles. Internally, compartments were re-organised to expand the hangar deck. The Chinese government said she was being converted for 'scientific research, experiment and training' but commercial satellite imagery of the shipyard clearly indicated she was being fitted out as an aircraft carrier.

Sea trials began in 2011 and the following November deck landing trials took place involving J-15 jets, in another first for the PLAN. The ship was formally handed over to the PLAN in September and officially named the PLANS *Liaoning,* to honour the province where she was overhauled. Chinese officials then suggested it would take four years to get her operational, involving an extensive period of sea training for her crew and air wing. This task proved more demanding than expected and it was not until 2018 that the carrier was formally assigned to an operational PLAN fleet. The trials did not go smoothly at first with the ship losing power on one occasion. Brazilian navy experts travelled to China to advise the PLAN during the work-up of the PLANS *Liaoning*.

In April 2018, the carrier and her battle group took part in a major naval exercise in the South China Sea to inaugurate her acceptance into frontline PLAN service. The exercise involved the carrier and her air group operating with support from land-based aircraft, including large airborne early warning aircraft and bombers equipped with anti-ship missiles. This concept of operation indicated that the PLAN was envisaging using her carrier to dominate the sea zones around China's coast.

### PLANS *LIAONING* AIR GROUP

The PLANS *Liaoning* has been seen at sea with an embarked air group totalling 36 aircraft and helicopters, including:
24 x J-15 fighters
6 x Z-18F anti-submarine warfare (ASW) helicopters
4 x Changhe Z-18J airborne early warning helicopters
2 x Z-9C rescue helicopters

| KUZNETSOV-CLASS AIRCRAFT CARRIER |
|---|
| **Displacement:** 67,500 long tons |
| **Length:** 304.5 m (999 ft) |
| **Beam:** 75 m (246 ft) |
| **Draft:** 8.97 m (29.4 ft) |
| **Propulsion:** Steam turbines with eight boilers and four fixed pitch propellers |
| **Speed:** 32 knots (59 km/h; 37 mph) |
| **Complement:** 1,960 crew, including 626 air group and 40 flag staff |
| **Armament:** 3 × Type 1130 CIWS, 3 × HQ-10 (18 cell missile system) |
| **Aircraft carried:** Up to 40 fixed wing and rotary wing aircraft |

**TOP: The J-15 was the first-ever Chinese jet to land on an aircraft carrier during the trials of PLANS *Liaoning*.** (PLAN)

**ABOVE LEFT: The hull of what became the PLANS *Liaoning* was towed from the Black Sea, around the Cape of Good Hope, to China before her re-build and upgrade could begin.** (US NAVY)

**ABOVE RIGHT: The PLANS *Liaoning* was overhauled and modernised at Dalian shipyard.** (GG001213)

# Plans *Shandong* (17)

## Conventionally Powered Aircraft Carrier

**MAIN PICTURE: The nearly finished PLANS *Shandong* at the Dalian shipyard in June 2019.** (TYG728)

**RIGHT: J-15 supersonic combat aircraft form the core of the PLANS *Shandong's* air group.** (PLAN)

The *PLANS Shandong* is China's first home-built aircraft carrier. She is designated as a Type 002 aircraft carrier and is named after the Chinese coastal province.

Externally, the ship looks similar in layout and concept to the PLANS *Liaoning,* but the new vessel features improved systems and a different design of ski jump to enhance aircraft performance. She is slightly longer than her sister ship at 315 metres and uses Chinese-built versions of the eight steam turbines used on the PLANS *Liaoning.*

The ship is designed to operate J-15-class supersonic fighter jets and helicopters in a variety of roles. To improve the jets' performance, the angle of the ski jump has been changed to 12° rather than 14°. Her hangar has been enlarged to allow more aircraft and helicopters to be accommodated under cover and the ship's island has been reduced in size by 10%. This, along with an extensive modification of the aft starboard deck means that eight more aircraft can be accommodated on the carrier's deck.

The island has been redesigned to separate the bridge and flight control room to improve efficiency. Four Active Electronically Scanned Arrays (AESAs) for the improved Type 346A S-band radar are installed on her island.

Chinese warship designers benefited from receiving some 30 tons of paper blueprints for the PLANS *Liaoning* from the Ukrainian ship yard where she was originally built. This allowed them to understand her design and manufacture, helping them speed her from keel-laying to entry-to-service in less than five years. They were also able to examine in detail the former Australian aircraft carrier, the HMAS *Melbourne,* which was sold for scrap to a Chinese company in the 1980s.

### PLANS *SHANDONG* AIR GROUP

The PLANS *Shandong* has been seen at sea with an embarked air group totalling 44 aircraft and helicopters, including:
32 x J-15 fighters
6 x Z-18F anti-submarine warfare (ASW) helicopters
2 x Changhe Z-18J airborne early warning helicopters
4 x Z-9C rescue helicopters

Work began in 2013 on the ship at the Dalian shipyard, where the PLANS *Liaoning* had been fitted out and returned to service. The keel was laid in 2015 in one of the facility's dry docks in conditions of great secrecy, and towards the end of the year satellite imagery appeared to confirm she was an aircraft carrier. By the end of the following year the hull, flight deck and superstructure were largely complete, allowing her to be floated out of the dock in April 2017.

During 2018 and 2019 a series of nine sea trials took place in the Bohai Sea to prepare the ship for frontline service. These became progressively more complex as the ship matured and her systems were brought online. Flight tests of J-15 fighters started in September 2018 and soon afterwards helicopter trials began, involving Z–18, Z–9 and J–15D helicopters.

The ship was formally commissioned into People's Liberation Army Navy (PLAN) service in December 2019 in a high-profile ceremony involving the country's leader, Xi Jinping. This symbolised the importance placed on aircraft carriers to the Chinese government's defence and foreign policy. Less than a year later the PLAN announced she had achieved initial operating capability or IOC.

In December 2020, the carrier and her supporting battlegroup took part in major naval exercises in the South China Sea, close to Hainan island. This followed a transit through the Taiwan Straits, bringing her aircraft in range of Taiwan, which is claimed by the Chinese government. Once in the exercise area in southern China the carrier and her aircraft supported amphibious landings involving the PLAN's new Type 075 landing ship.

The entry to service of the PLANS *Shandong* has been far smoother and quicker than her sister ship. This probably reflects increasing expertise and experience of the PLAN and the Chinese shipbuilding industry in aircraft carrier design, manufacturing, and operation. The PLANS *Liaoning* was also in poorer material state when she was delivered to China and so was harder to bring back to a peak level of operational effectiveness.

**ABOVE:** **The PLANS *Shandong* under construction at the Dalian shipyard.** (TYG728)

**LEFT:** **Deck crews of Chinese aircraft carriers have followed the US tradition of giving different trades their own colour-coded jackets.** (PLAN)

| TYPE 002 CLASS |
|---|
| **Displacement:** 66,000 to 70,000 tons |
| **Length:** 315 m (1,033 ft) |
| **Beam:** 75 metres (246 ft) |
| **Propulsion:** Conventional steam turbines, 4 shafts |
| **Speed:** 31 knots (36 mph; 57 km/h) |
| **Armament:** three Type 1130 CIWS, three HQ-10 (18 cell missile system) |
| **Aircraft carried:** 44 total aircraft and helicopters |

# FS *Charles de Gaulle* (R91)

## Nuclear-Powered Aircraft Carrier

**RIGHT: US Navy C-2 Greyhound aircraft routinely fly carrier on-board delivery missions to support the FS *Charles de Gaulle*.** (US NAVY)

The FS *Charles de Gaulle* is the flagship of the French Navy, or *Marine Nationale*. She is the only nuclear powered aircraft carrier outside the US Navy and is also the only non-American carrier to be equipped with catapult launch systems. The carrier is named after the leader of the Free French Forces during World War Two, who later rose to be President of France between 1958 and 1969.

Work on the FS *Charles de Gaulle* began in the 1970s to replace France's two conventionally powered aircraft carriers, the FS *Foch,* and FS *Clemenceau*, but the hull of the new ship was not laid down in Brest until 1989. The ship was originally named the FS *Richelieu* after the famous cardinal, but it was changed in 1987 on order of Prime Minister Jacques Chirac who was a leading member of the former president's political party.

**BELOW: The FS *Charles de Gaulle* is the French navy's flagship and was the biggest warship of any European navy until HMS *Queen Elizabeth* entered Royal Navy service in 2017.** (DCNS)

At some 45,000 tons the FS *Charles de Gaulle* was the largest warship in service with a European navy until HMS *Queen Elizabeth* entered service with the Royal Navy in 2017. The cost of the ship when it was completed ran to €3.1bn.

Throughout the subsequent decade, progress of the FS *Charles de Gaulle* was slowed because of budget cuts and it ended up not being commissioned until May 2001, more than five years behind schedule. A series of technical issues were also discovered during her sea trials. First the flight deck was found to be too short to safely operate the E-2C Hawkeye airborne early warning aircraft. Then she suffered a major failure in one of her propellers, and faults were found in the other propeller. The issue was traced to manufacturing issues and the propellers were replaced with the old propellers taken from the FS *Clemenceau*. This got the FS *Charles de Gaulle* back in action but reduced her top speed until new propellers could be installed at a later overhaul. In 2010 the ship suffered a major electrical failure and had to return to port for repairs.

Her nuclear reactor has been refuelled twice during the ship's life - in 2007 and again during a major refit in 2015-17. The ship's ammunition magazines have been upgraded to accommodate the ASMP-A nuclear-armed missile and the SCALP EG air-launched cruise missile. Enhanced satellite communications systems have also been fitted to the ship.

The FS *Charles de Gaulle* sailed from her home port at Toulon on France's Mediterranean coast for her first operational cruise on November 21, 2001 after she was ordered to join the US-led mission to defeat the Taliban in Afghanistan. Super Étendard aircraft from the carrier carried out some 140 bombing and reconnaissance missions over the country. The carrier subsequently returned to the Indian Ocean and her aircraft again flew missions over Afghanistan in 2005 and 2010.

In 2011 the FS *Charles de Gaulle* played a leading role in the Libyan war, flying strike and reconnaissance missions as part of the NATO-led air campaign. There were few NATO air bases within striking range of Libya, so the carrier was able to bring her aircraft close to the country's coast and launch strike aircraft on missions that did not have to rely on air-to-air refuelling support. Until she returned to port in August, the ship's aircraft flew some 1,350 missions over Libya. Two US Navy C-2A Greyhounds were assigned to FS *Charles de Gaulle* to conduct operational carrier on-board delivery (COD) missions during the intervention in Libya.

From 2015, the carrier was regularly deployed to the Eastern Mediterranean and Northern Arabian Gulf to launch aircraft to attack Islamic State forces in Iraq and Syria. Two cruises in 2015 were followed by deployments in 2016, 2019 and 2020. During these deployments, the French carrier was routinely integrated into coalition task groups, working with US, British and other allied navies.

Up until 2016, the FS *Charles de Gaulle* deployed with a mixed air group of Rafale and Super Étendard combat aircraft, as well as E-2Cs and helicopters. After the retirement of the Super Étendard, the carrier deployed with Rafale fighters which by then had been cleared to fly in both air-to-air and air-to-ground roles.

**ABOVE: The French aircraft carrier FS *Charles de Gaulle* underway in the Red Sea in April 2019.** (US NAVY)

| *CHARLES DE GAULLE* CLASS |
|---|
| **Displacement:** 42,500 tonnes |
| **Length:** 261.5 m (858 ft) |
| **Beam:** 64.36 m (211.2 ft) |
| **Draught:** 9.43 m (30.9 ft) |
| **Propulsion:** Two Areva K15 pressurised nuclear water reactors (PWR), two Alstom steam turbines and two shafts |
| **Speed:** 27 knots (50 km/h) |
| **Complement:** Ship's company 1,350 and 600 air wing personnel |
| **Armament:** Four eight-cell A-43 Sylver launchers carrying the MBDA Aster 15 surface-to-air missile, two six-cell Sadral launchers carrying Mistral short range missiles and eight Iat 20F2 20 mm cannons. |
| **Aircraft Carried:** 30–40 Aircraft Or Helicopters |

**EMBARQUED AIR GROUP (LE GROUPE AÉRIEN EMBARQUÉ)**

| UNIT | TYPE | BASE | ROLE |
|---|---|---|---|
| Flottille 4 | E-2C Hawkeye | Lann Bihoue | Carrier Airborne Early Warning |
| Flottille 11 | Rafale M | Landivisiau | Strike Fighter |
| Flottille 12 | Rafale M | Landivisiau | Strike Fighter |
| Flotille 17 | Rafale M | Landivisiau | Strike Fighter |
| Det. PEDRO | AS365 Dauphin | Hyères | Plane guard |

Typically, two Rafale squadrons are expected to rotate in the CdG carrier air group, and a pair of E-2C would supplement them as well as 2/4 AS365 Dauphin helicopters. In 2019 CdG operated 35 aircraft during exercises, its record: two Dauphin helicopters, 30 Rafale M, two E-2C Hawkeye and one NH90 NFH Caiman.

**BELOW: International warships, such as HMS *Kent*, are often tasked to provide close protection for the FS *Charles de Gaulle*.** (UK MOD/CROWN COPYRIGHT)

**RIGHT:** **The INS *Vikramaditya* (left) can be compared to the RFS *Admiral Kuznetsov* (right) when both ships were at anchor off Severomorsk before the Indian carrier sailed for her new home.** (GORBATUY111)

**BELOW:** **Sea King anti-submarine helicopters operate from the INS *Vikramaditya* to provide close protection against underwater threats.** (INDIAN NAVY)

The Indian Navy has operated aircraft carriers for nearly 60 years, and it continues to invest in maritime aviation to protect its interests beyond the country's coasts. Its first carrier, the INS *Vikrant*, launched strike missions during the 1971 Indo-Pakistan war. In her day, the INS *Vikrant* was a very modern ship complete with steam catapult and angled fight deck, allowing her to operate Sea Hawk jets. In her final years in service, the carrier operated the Sea Harrier jump jet fighter. In 1986 she was replaced by the INS *Viraat*, the former Royal Navy carrier HMS *Hermes,* and embarked Sea Harrier fighter jets until 2016 when the ship retired.

| INS *VIKRAMADITYA* AIR GROUP | | |
|---|---|---|
| NAVAL AIR SQUADRON | NAME | AIRCRAFT |
| INAS 300 | White Tigers | MiG 29KUB |
| INAS 303 | The Black Panthers | MiG 29K |
| INAS 321 | The Angels | HAL Chetak |
| INAS 322 | The Guardians | HAL Dhruv |
| INAS 330 | The Harpoons | Sea King |
| INAS 339 | The Falcons | Kamov Ka-31 |

India's current operational carrier, the INS *Vikramaditya*, has a colourful history stretching back to the 1980s when she was commissioned into the Soviet navy as the Kiev-class cruiser *Baku*. With the demise of the Soviet Union, she became the *Admiral Gorshkov* but budget cuts in the resultant Russian Navy meant she was withdrawn from service in 1996. In 2004 the Indian Navy bought the ship, and she began an extensive upgrade at the Sevmash shipyard in Severodinsk in northern Russia. One of the key improvements was to install a 280 metre long fight deck to allow her to operate MiG-29K/UBK supersonic jet fighters. The conversion stripped out the cruise and surface-to-air missile launchers from the forward deck of the ship and included the installation of arrestor hooks, as well as extensive modernisation of her machinery and electronic systems. Israeli-made Barak

# INS *Vikramaditya* (R33)

## Conventionally Powered Aircraft Carrier

**LEFT: India's INS *Vikramaditya* is a former Soviet aircraft carrier that has been extensively modified to operate fast jets.** (INDIAN NAVY)

**BELOW: An Indian Sea Harrier overflies the INS *Vikramaditya*.** (INDIAN NAVY)

long range air defence missiles were installed for the first time in a Soviet/Russian warship.

To boost the performance of the carrier's jets, a 14° degree ski jump was installed on her bow. The ship can operate a mix of jets and helicopters, with a capacity to accommodate up to 34 airframes. As well as replacing its old Sea Harriers with Russian-made MiG-29Ks, the Indian navy ordered Ka-31 airborne early warning helicopters to replace its British-supplied Sea Kings.

The conversion of the ship was the subject of a long running dispute between the Indian Navy and the Russian shipyard with complaints of poor workmanship and sub-standard components being used. She broke down during her trials, which pushed back the handover date. There was also a dispute over the price of the conversion work and eventually the Indians ended up paying more than $2 billion for the ship compared to the initially agreed price of $1.3 billion. The delays meant INS *Viraat* had to be overhauled and extended in service.

When the Indian navy bought the ship, it was envisaged that she would remain in service for 40 years but the problems with poor work during her conversion led to speculation that she might have to be retired early.

Indian sailors and pilots travelled to Russia to be trained on the ship and their new aircraft before she sailed to India. A contingent of Russian technical support staff stayed on the ship for a year to make sure any breakdowns could be resolved. For a brief period, the Indian navy had two carriers in service.

Since entering service, the carrier has participated in exercises around the Indian Ocean region and in trials for the naval variant of the HAL Tejas Light Combat Aircraft, which was the first Indian-made aircraft ever to land on an aircraft carrier.

| INS *VIKRAMADITYA* |
|---|
| **Displacement:** 45,400 long tons |
| **Length:** 284 metres (932 ft) |
| **Beam:** 61 metres (200 ft) |
| **Draught:** 10.2 metres (33 ft) |
| **Propulsion:** Eight turbo-pressurised boilers, 4 shafts |
| **Speed:** +30 knots (56 km/h) |
| **Complement:** 110 officers and 1500 sailors |
| **Armament:** 4 × AK-630 CIWS, Barak 8 long range surface-air-missiles |
| **Aircraft carried:** 36 aircraft and helicopters |

**RIGHT: AV-8B Harrier jump jets are currently the core of ITS *Cavour* air group.** (ALDO BIDINI)

The Italian navy's second aircraft carrier is designed as a multi-role platform that can switch between air, amphibious, anti-submarine, and humanitarian operations. She is named after the Count of Cavour, who was the first prime minister of the newly independent Italy in the 19th century. Initially, the ship was to be named after the Renaissance Genoese admiral and general Andrea Doria, but this changed as the carrier was being built.

ITS *Cavour* was laid down in 2001 at Fincantieri's shipyard in Riva Trigoso and was launched three years later. The ship was eventually commissioned into the Italian navy in June 2009.

**AIRCRAFT GROUP (GRUPPO AEREI IMBARCATI - GRUPAER)**

Operations Unit (Reparto Operazioni) with AV-8B+ Harrier II fighters (being replaced by F-35B Lightning II)
4th Helicopter Group (Quarto Gruppo Elicotteri - GRUPELICOT QUATTRO) with SH-90A, AB212ASW ASuW/ASW helicopters

**BELOW: The ITS *Cavour* is Italy's newest and largest aircraft carrier.** (GAETAN056)

It was built with a 244 metre flight deck and 14° ski jump to allow the operation of AV-8B Harrier jump jets. Her flight deck and hangar usually embarks either 16 Harriers or F-35B Lightning jumps jets or 12 helicopters, usually a mix of EH101s, NH 90s, or SH-3Ds. There are two 30 ton aircraft lifts up to the flight deck from the hangar and two 15 ton lifts for aircraft ordnance. When operating as an aircraft carrier the ship can accommodate 10 AV-8Bs or F-35Bs in the hangar deck and take five or six on deck.

# ITS *Cavour* (550)

## Italian Naval Air Power

The 27,000 ton carrier is designed with its own internal well deck that can launch and recover four landing craft or hovercraft. Up to 100 vehicles can be accommodated in the hangar deck and moved to the well deck by internal ramps. As well as her 486 strong crew, the ship usually accommodates 211 air wing staff, 140 task force command staff and 450 marines. The ship also has a large hospital with three operating theatres.

The ship was mobilised in early 2010 to lead Italy's contribution to Operation White Crane to deliver humanitarian aid to Haiti after an earthquake devastated the country. In response to an increase in migrant flows across the Mediterranean from Libya in 2015, the European Union launched Operation Sophia to intercept hundreds of small boats carrying the migrants. The ITS *Cavour* was dispatched to the Gulf of Sitre to act as the flagship of the operation.

When the ITS *Cavour* first entered service, she usually embarked a fixed air component of AV-8Bs. Italy has since joined the F-35 programme and it now intends to take delivery of 15B variants that can operate in vertical take-off and landing mode, using their revolutionary lift-fan system.

The ship underwent a 16 month programme of modifications at the Military Maritime Arsenal in Taranto to allow her to operate the F-35B. The flight deck was reinforced with heat resistant coating to protect it from the hot exhaust of the jet's lift fan. Other modifications included improvements to the ship's hangar, equipment store, aviation fuel storage, data distribution network, sensors, and electronics.

In January 2021, the ship set sail from Taranto for the east coast of the United States to take part in F-35B integration trials in co-operation with the US Navy and Marine Corps. Experts from the US Navy and Lockheed Martin embarked on the ship in preparations for the first F-35B landing on the deck by an USMC instrumented trials aircraft. The test programme is intended to certify the ship fit to operate the new aircraft. This programme was mirrored on the ship-integration trials carried out on the UK carrier HMS *Queen Elizabeth* in 2017. The first F-35Bs landed on the ITS *Cavour* on March 1, 2021.

Once the trials are complete, the Italian navy plans to launch a series of work-up training programmes to prepare the ship's crew to operate the new aircraft. By early 2021 the Italian navy had taken delivery of two F-35Bs, but it will be three years until they are all delivered. Then the ITS *Cavour* and her air group will declare initial operating capability in 2024. It is expected that the last F-35Bs will be delivered in 2027 to allow full operating capability to be declared.

| CAVOUR-CLASS |
| --- |
| **Displacement:** 26,700 long tons |
| **Length:** 244 m (800 ft 6 in) |
| **Beam:** 29.1 m (95 ft 6 in) |
| **Draught:** 8.7 m (28 ft 7 in) |
| **Propulsion:** Four General Electric/Avio LM2500+ gas turbines, two shafts |
| **Speed:** +29 knots (54 km/h; 33 mph) |
| **Complement:** 1,202 crew with option to surge additional 90 |
| **Armament:** Four 8-cell A-43 Sylver launchers carrying the MBDA Aster 15 surface-to-air missile, two Oto Melara 76/62 mm Strales guns, three Oerlikon Contraves 25/80 mm anti-aircraft guns |
| **Aircraft carried:** Up to 25 fixed wing aircraft or helicopters |

**ABOVE: An F-35B Lightning test aircraft hovers above the ITS *Cavour* during flight trials off the US in March 2021.** (US NAVY)

**BELOW: ITS *Cavour* at anchor off Naples.** (ARMANDO MANCINI)

# ITS *Giuseppe Garibaldi* (551)

## Conventionally Powered Aircraft Carrier

**RIGHT: The ITS *Giuseppe Garibaldi* was the Italian navy's first aircraft carrier.** (ROYAL NAVY)

**BELOW: AV-8B Harriers and Merlin helicopters embarked on the ITS *Giuseppe Garibaldi*.** (US NAVY)

The ITS *Giuseppe Garibaldi* was laid down in 1981 as a helicopter-equipped anti-submarine warfare ship. She is named after the 19th century hero of Italian re-unification and was the first ever flat top to be built for the Italian navy.

The ship was commissioned in 1985 and for the first decade she operated Sea King anti-submarine helicopters. Under a 1937 Italian law only the country's air force could operate fixed wing aircraft which stifled the Italian navy's ambition to field Harrier jump jets.

Trials of Harriers took place on the Italian helicopter cruiser ITS *Andrea Doria* in the later 1960s, but it was not until 1989 that the Italian government changed the law and gave its navy approval to buy AV-8Bs Harriers. The *Giuseppe Garibaldi* can embark an air group of up to 18 AV-8B or helicopters.

In 2003 she underwent a major overhaul to install improved communications and extend the flight deck by removing air defence weapons from the rear deck.

In 1995 the ITS *Giuseppe Garibaldi* sailed to Somalia for her first combat cruise to provide air support for UN peacekeeping troops as they withdrew from the country. Her Harriers flew over 100 missions but did not drop any bombs in anger.

It was not until 1999 that the ship's AV-8Bs got their combat debut during the Kosovo war, flying in support of the NATO air campaign. This was the first combat employment of carrier aviation by the Italian navy. Between May and June 1999, the ship's Harriers flew 30 combat sorties, dropping laser guided bombs and firing Maverick air-to-ground missiles.

In 2001 the ITS *Giuseppe Garibaldi* sailed to the Indian Ocean to support the US campaign in Afghanistan and her jets flew patrols over the land-locked nation. Some 160 laser guided bombs were dropped by the ship's Harriers during the 2011 Libya campaign.

### GIUSEPPE GARIBALDI-CLASS

**Displacement:** 13,930 long tons

**Length:** 180.2 m (591 ft)

**Beam:** 33.4 m (110 ft)

**Draught:** 8.2 m (27 ft)

**Propulsion:** Four General Electric/Avio LM2500 gas turbines

**Speed:** 30kts (56km/h; 35mph)+

**Complement:** 830 crew, including 180 in air group and 100 command staff

**Armament:** Two Mk.29 octuple launchers for Sea Sparrow/Selenia Aspide surface-to-air missile, three Oto Melara Twin 40L70 DARDO guns and two 324mm triple torpedo tubes

**Aircraft carried:** Up to 18 fixed wing aircraft and helicopters

### AIRCRAFT GROUP (GRUPPO AEREI IMBARCATI - GRUPAER)

Operations Unit (Reparto Operazioni) with AV-8B+ Harrier II fighters (being replaced by F-35B Lightning II)
4th Helicopter Group (Quarto Gruppo Elicotteri - GRUPELICOT QUATTRO) with SH-90A, AB212ASW ASuW/ASW helicopters

# JS *Izumo* (DDH-183)

## Light Aircraft Carrier

Work is underway to convert the JS *Izumo* into what the Japanese Maritime Self Defense Force (JMSDF) terms as a 'light aircraft carrier'. The 27,000 ton ship was commissioned into JMSDF service in 2015. She was then the largest Japanese warship to be built since the end of World War Two and also the first ever post-war Japanese aircraft carrier.

The ship is named after the province of Izumo; an Imperial Japanese Navy armoured cruiser also bore the name in 1898. Work began at the IHI Marine United shipyard in Yokohama in 2011, with the carrier projected as costing $1.5 billion. The JS *Izumo* and her sister ship were originally designated as a 'multi-purpose operation destroyer' because the country's constitution prohibits the fielding of offensive weapons by the JMSDF that can project power beyond Japan's territorial waters.

Up to 28 helicopters can be embarked on the ship, along with 400 marines and 50 3.5 ton small trucks, with helicopter spots on the deck to allow simultaneous operations by five helicopters.

In December 2018, the Japanese government changed its policy and decided that it would buy F-35B Lightning jump jets so they could be embarked on the Izumo-class ships. Plans were made to convert JS *Izumo* to carry up to 14 F-35Bs and an order for 40 of the jets is in the process of being placed. Japanese Ground Self Defense Force V-22 Osprey tiltrotors are also expected to operate from the ship.

The conversion of the ship involved the strengthening of the flight deck by the application of a heat-resistant coating to protect it from the hot exhaust from the F-35B's lift-fan system. A new power-supply system was also installed to enable F-35B operations, and her bow shape is also to be changed. The conversion is scheduled to be complete in 2024. A further modification is planned for later in that year to alter the interior compartments to make aircraft maintenance more efficient. There are currently no plans to install a ski jump.

**ABOVE: The JS *Izumo* will be the first Japanese warship since World War Two to operate fixed wing combat aircraft.** (YAMADA TARO)

| IZUMO-CLASS |
|---|
| **Displacement:** 27,000 long tons |
| **Length:** 248 m (813 ft 8 in) |
| **Beam:** 38 m (124 ft 8 in) |
| **Draft:** 7.5 m (24 ft 7 in) |
| **Propulsion:** Four GE/IHI LM2500IEC gas turbines |
| **Speed:** More than 30 kts (35 mph; 56 km/h) |
| **Complement:** 970 including crew and embarked troops |
| **Armament:** Three Phalanx CIWS and two SeaRAM CIWS |
| **Aircraft carried:** 28 aircraft or helicopters |

# JS *Kaga* (DDH-184)

## Multi-Purpose Operation Destroyer to be Light Aircraft Carrier

**RIGHT: The JS *Kaga* shares the name with the Imperial Japanese Navy aircraft carrier that launched aircraft to attack the US Navy base at Pearl Harbor in 1941.** (HUNINI)

**BELOW: Conversion work on the JS *Kaga* is soon to start to enable her to operate the F-35B Lightning.** (YAMADA TARO)

The JS *Kaga* is the second ship of the Izumo-class 'multi-purpose operation destroyer' and is scheduled to begin conversion into a light aircraft carrier later this year.

The project to convert the two ships is part of the Japanese government's effort to counter threats from North Korea and China, including territorial claims by Beijing against Japanese islands in the East China Sea. By building up its maritime airpower the Japanese Maritime Self Defense Force aims to be able to provide air cover for its warships operating at the edge of Japan's territorial waters.

She bears the same name as the World War Two Imperial Japanese Navy aircraft carrier, which launched aircraft to take part in the 1941 attack on the US naval base at Pearl Harbor. The modern-day JS *Kaga* is slightly bigger than the World War Two-era carrier of the same name.

| IZUMO-CLASS |
|---|
| **Displacement:** 27,000 long tons |
| **Length:** 248 m (813 ft 8 in) |
| **Beam:** 38 m (124 ft 8 in) |
| **Draft:** 7.5 m (24 ft 7 in) |
| **Propulsion:** Four GE/IHI LM2500IEC gas turbines |
| **Speed:** More than 30 kts (35 mph; 56 km/h) |
| **Complement:** 970 including crew and embarked troops |
| **Armament:** Three Phalanx CIWS and two SeaRAM CIWS |
| **Aircraft carried:** 28 aircraft or helicopters |

Work began on the $1.05 billion ship at the IHI Marine United shipyard in Yokohama in 2013 and the ship was commissioned in March 2017.

Both ships of the class are built to the same standard. It is currently operating in an anti-submarine role with nine SH-60J/K Sea Hawk helicopters embarked. MCH-101 minesweeping helicopters and troop carrying CH-47J helicopters have also been carried on the ships.

Once the conversion starts, she will have her bow extended and flight deck protected against the hot exhaust of F-35Bs. Following the completion of the conversion the ship is expected to be able to operate up to 14 F-35Bs.

A year after she was commissioned, the JS *Kaga* led a Japanese naval task group on a goodwill visit to the Indian Ocean. As well as visiting Sri Lanka, the ship carried out exercises with UK, Philippine, and Indonesian navy vessels. In 2019 US President Donald Trump made a high-profile visit to the ship as part of the Japanese government's drive to promote its naval build-up.

# *SPS Juan Carlos I* (L61)

## Amphibious Assault Ship/Aircraft Carrier

Spain's flagship was laid down in 2005 and was completed five years later to allow the Spanish navy's previous carrier, the SPS *Príncipe de Asturias,* to be retired. The ship is named after the former king of Spain, Juan Carlos I. Spain has a long tradition of operating aircraft carriers stretching back to the 1920s and the country is looking to replace its current AV-8B Harrier jump jets with the F-35B Lightning combat aircraft.

The SPS *Juan Carlos I* was initially known as a Strategic Projection Vessel because of its multi-role capabilities. As well as being the main aircraft carrier of the Spanish navy, it is also the service's main amphibious assault ship and can also be re-tasked to carry out humanitarian operations. Her crew of 900 can be complemented by another 1,200 marines or passengers.

She has a ski jump to improve the performance of the Spanish navy's AV-8B Harriers. Her deck and hangar can accommodate up to 30 helicopters when she is configured for amphibious assault operations or a combination of 12 Harriers and 12 helicopters when operating as aircraft carrier. The ship's well dock can accommodate four landing craft or a single hovercraft.

SPS *Juan Carlos I* was one of the first major warships to be fitted with diesel-electric propulsion to replace old propeller shafts and it also has a pair of azimuthal pods. These rotate and mean it does not need rudders to direct the ship.

Spain's Navantia shipyards have since sold the design of the vessel to Australia in 2007, which built two of the vessels and called them the Canberra-class helicopter carriers. Navantia built the hull of the ships in Spain and then they were fitted out in Australia.

Turkey then bought the design as the basis for its first large amphibious assault/light aircraft carrier. The first of its class, the TCG *Anadolu,* is being built at the Sedef Shipyard in Istanbul. She retains the ski jump to allow it to operate the F-35B jump jet.

**ABOVE: The design of the SPS *Juan Carlos I* has been sold around the world.** (JAVICASELLI)

| *JUAN CARLOS I* AIR GROUP | | |
|---|---|---|
| UNIT | AIRCRAFT | ROLE |
| 03 Escuadrilla | AB212 | ASW |
| 005 Escuadrilla | SH-3D/G Sea King | ASW/AEW |
| 009 Escuadrilla | Harrier II | Strike/Air Defence |
| 010 Escuadrilla | SH-60B Seahawk | ASW/utility |

| JUAN CARLOS I CLASS |
|---|
| **Displacement:** 26,000 long tonnes |
| **Length:** 230.82 m (757.3 ft) |
| **Beam:** 32 m (105 ft) |
| **Draught:** 6.9 m (23 ft) |
| **Propulsion:** 2 × Propulsion Pods |
| **Speed:** 21 kts (39 km/h; 24 mph) |
| **Compliment:** 261 crew, as well as 913 marines and 172 air wing personnel |
| **Armament:** Four 20 mm guns, Vertical Launch Missile System, four 12.7 mm machine guns |
| **Aircraft carried:** Up to 25 aircraft and helicopters |

**LEFT: The Spanish navy is one of the three remaining air arms still operating the AV-8B Harrier jump jet and they form the core of the SPS *Juan Carlos I's* air group.** (US NAVY)

# RFS *Admiral of the Fleet of the Soviet Union Kuznetsov* (063)

## Conventionally Powered Aircraft Carrying Cruiser

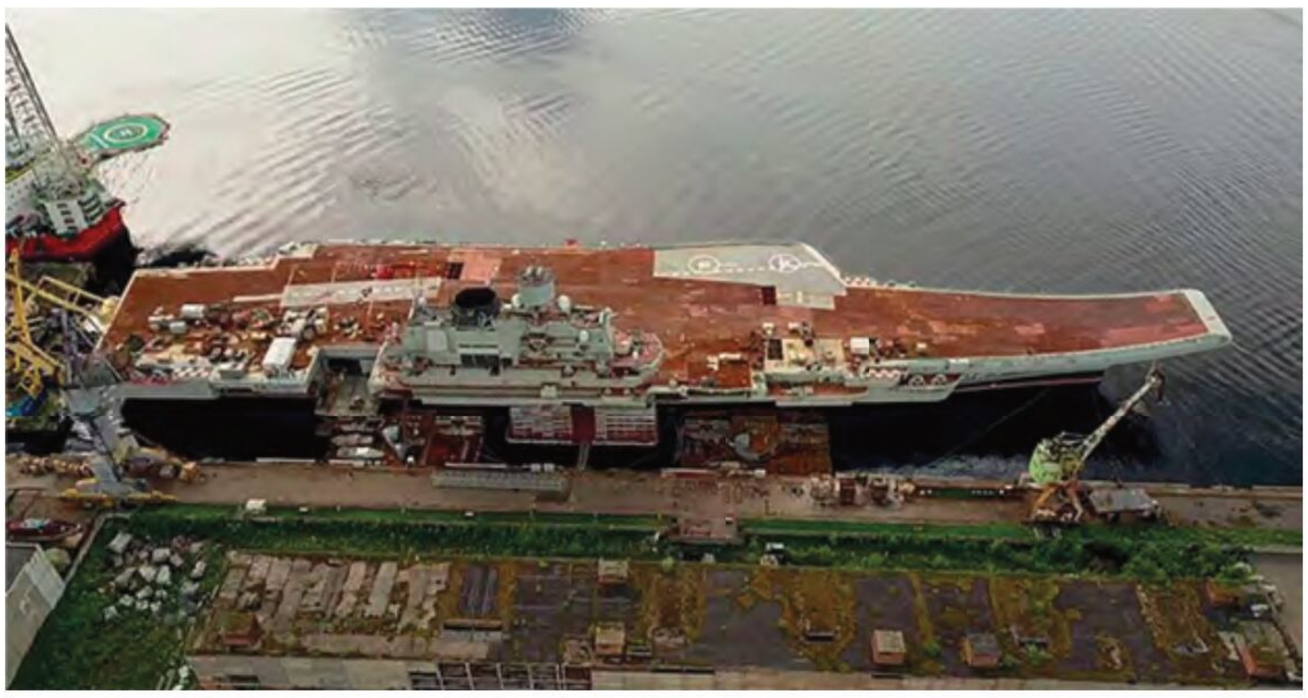
**BELOW: Russia's only aircraft carrier, the RFS *Admiral Kuznetsov*, cruising through the English Channel en route to the Mediterranean in 2011.** (MOD/CROWN COPYRIGHT)

Russia's only aircraft carrier is known universally as the RFS *Admiral Kuznetsov* and is named after the head of Soviet naval forces during World War Two.

The ship has had a very long and chequered history since the Soviet military ordered her to be built in 1981. Work began at the Nikolayev shipyard on the Black Sea, which is now in independent Ukraine, in 1982. During her construction she had four names. First, she was named *Riga* after the Latvian city, then *Leonid Brezhnev* after the Communist party chief. In 1989 she was re-titled the *Tbilisi* after the capital of Georgia. The ship sailed for her first sea trials in 1989 but was not fully complete. A year later the 43,000 ton ship was again renamed, this time adopting the name she bears today.

In the dying days of the Soviet Union, she sailed from Nikolayev and transited the Bosporus and Mediterranean before heading to her new home at Severomorsk to join the Northern Fleet. The designation of the ship as an 'aircraft carrying cruiser' allowed her to transit the Bosporus - otherwise she would have been prohibited from the seaway under the terms of Montreux convention. Also, her departure from the Nikolayev yard meant she escaped falling under the control of the newly independent Ukraine and suffering the fate of being sold off or scrapped as happened to the other two aircraft carriers under construction at the yard.

| KUZNETSOV-CLASS |
|---|
| **Displacement:** 57,700 long tons |
| **Length:** 305 m (1,001 ft) |
| **Beam:** 72 m (236 ft) |
| **Draft:** 10 m (33 ft) |
| **Propulsion:** Eight turbo-pressurised boilers and four fixed pitch propellers |
| **Speed:** 29 kts (33 mph; 54 km/h) |
| **Complement:** 1,690 ship's crew and 626 air group personnel |
| **Armament:** Six AK-630 300m anti-aircraft guns, eight CADS-N-1 Kashtan CIWS and 3K87 Kortik surface-to-air missile system, 12 P-700 Granit surface-to-surface missiles and 3K95 Kinzhal surface-to-air missile system , RBU-12000 UDAV-1 ASW rocket launchers |
| **Aircraft carried:** 30 aircraft and helicopters |



**ABOVE: The ski jump of the RFS *Admiral Kuznetsov* allows her to operate fast jet fighters.** (RUSSIAN MINISTRY OF DEFENCE)

**LEFT: Since 2017 the RFS *Admiral Kuznetsov* has been out of action undergoing a refit and overhaul in Murmansk.** (REDDIT.COM)

**BELOW: In October 2016 the RFS *Admiral Kuznetsov* set sail for the Mediterranean to launch her jets into action over Syria in a major first for the Russian navy.** (MOD/CROWN COPYRIGHT)

The formal demise of the Soviet Union in December 1991 meant the RFS *Admiral Kuznetsov* by default became the flag ship of the newly established navy of the Russian Federation.

The early 1990s was a time of free-falling defence spending in Russia and the Northern Fleet struggled to bring its new aircraft carrier into service. She only went to sea with a full air group in 1993. The carrier led a naval deployment to the Mediterranean in 1996 but the ship was dogged by mechanical problems during the cruise. Up to 2012 she made three more cruises to the Mediterranean but even these were not without problems and a sailor died in a major fire on the ship off the Turkish coast in 2009.

Russia's intervention in the Syrian conflict from 2015 prompted Moscow to begin preparing to dispatch the carrier and a naval battlegroup to the region. The force set sail in October 2016 and passed through the English Channel a few days later, prompting the British defence secretary Michael Fallon to call the carrier the 'Ship of Shame' because it seemed she was heading to take part in the Syrian conflict on the side of the Damascus government. On November 21, 2016 Su-33 jets from the ship carried out the first ever combat missions by Russian or Soviet carrier-borne aircraft when they launched bombing missions around the rebel-held city of Aleppo.

The mission was not without its problems, and faults in the ship's arrestor wires led to two jets being unable to land back on deck, forcing them to ditch. Until the problem was resolved the air group temporarily relocated to a Russian-controlled air base in Syria to continue strike operations.

Budget problems led to speculation that the ship might have to be scrapped but in 2017 it was decided to begin a major upgrade. This was beset by technical problems. In October 2018, while the carrier was being manoeuvred out of a floating dry dock in Murmansk, the dock sank, and a crane crashed into the flight deck causing some damage. Then when she was moored alongside in Murmansk in December 2019 a fire broke out on several decks, causing considerable damage and killing two dockyard workers and injuring 14. The overhaul project was further delayed when contractors who were modifying the dry dock to take the ship in place of the floating berth reported they could not complete the work on time. The ship is not now expected to return to service until 2022 at the earliest.

| ADMIRAL KUZNETSOV AIR GROUP IN MEDITERRANEAN SEA, OCT 2016 TO FEB 2017 | | |
|---|---|---|
| AIRCRAFT | ROLE | NUMBER |
| 100th Shipborne Fighter Aviation Regiment | | |
| MiG-29KUBR | Strike | 4 |
| 279th Shipborne Fighter Aviation Regiment | | |
| Su-33 | Fighter/Strike | 10 |
| 830th Independent Shipborne Anti-Submarine Helicopter Regiment | | |
| Ka-29 | Helicopter Gunship | 4 |
| Ka-31 | Airborne Early Warning Helicopter | 2 |
| Ka-52K | Attack Helicopter | 2 |
| Ka-27PL | Anti-Submarine Helicopter | 4 |
| Ka-27PS | Search and Rescue Helicopter | 4 |

# HMS *Queen Elizabeth* (RO8)

## Conventionally Powered Aircraft Carrier

**RIGHT: HMS *Queen Elizabeth's* badge harks back to the Tudor monarch she is named after.** (TIM RIPLEY)

The first of the new Queen Elizabeth-class aircraft carriers is named after the World War One-era super-dreadnought battleship, HMS *Queen Elizabeth*, which in turn was named after the Tudor monarch, Queen Elizabeth, who famously oversaw the defeat of the Spanish Armada in 1588. The modern HMS *Queen Elizabeth* carries the battle honours and crest – a Tudor rose - of the original battleship.

She is the largest ever Royal Navy warship and the most expensive surface ship yet built in the United Kingdom. After a decade of development and design work, the formal go-ahead for the two 65,000 ton Queen Elizabeth-class aircraft carriers was announced in July 2007. The two ships were contracted to cost £3.9 billion. Work began on the construction of HMS *Queen Elizabeth*

in July 2009 with the first steel being cut at BAE Systems' Govan shipyard in Glasgow.

The first phase of the project included the fabrication of 'ship blocks' at six shipyards around the UK, which incorporated key structural elements, as well as piping and electrical wiring. Each block was then floated on large barges to Babcock International's Rosyth dockyard in Fife, where the final assembly of the ship was being conducted under the umbrella of the Aircraft Carrier Alliance, which was led by BAE Systems and Babcock.

The first two blocks were welded together at Rosyth in June 2011 and over the next two years the ship took shape. She was 80% complete by September 2013 and was formally named by HMS *Queen Elizabeth* on July 4, 2014. Thirteen days later she was floated out of the Rosyth dry dock in the shipyard's basin to allow the final fitting out to begin.

This was largely complete by mid-2017 and on June 26 of that year she was manoeuvred out of the basin into the Firth of Forth to begin her contractors' sea trials. After a brief visit to Invergordon anchorage the

**BELOW: The ski jump of HMS *Queen Elizabeth* gives the ship a distinctive profile.** (MOD/CROWN COPYRIGHT)

**LEFT: During her work-up trials in 2018, HMS *Queen Elizabeth* sailed to Gibraltar with Merlin HMA1 helicopters embarked.** (MOD/CROWN COPYRIGHT)

| QUEEN ELIZABETH-CLASS |
|---|
| **Displacement:** 65,000 tons |
| **Length:** 280 m (920 ft) |
| **Beam:** 73 m (240 ft) |
| **Draught:** 11 metres |
| **Speed:** 25 kts (46 km/h) |
| **Capacity:** 1,600, of which 679 are usually the ship's crew |
| **Armament:** Three Phalanx CIWS, four 30mm DS30M Mk2 guns and six mini-guns |
| **Aircraft carried:** 40 aircraft and helicopters (65+ aircraft surge capacity) |

following month to inspect possible damage to her propeller shafts, she set sail for her new home at HM Naval Base Portsmouth and arrived on August 16. The ship was formally accepted by the Royal Navy on December 7 during a ceremony while she was docked at Portsmouth. The final costs of the two Queen Elizabeth–class carriers have now been confirmed by the Ministry of Defence to be £6.1 billion.

During February 2018 HMS *Queen Elizabeth* carried out operational sea training in the Western Approaches before heading out across the Atlantic on August 18 to begin deck landing trials with F-35B Lightning aircraft off the east coast of the United States. The first landing and take-off by a US-owned but British-piloted F-35B took place on September 25 at the start of the trials process.

After a technology insertion period in early 2019, which saw the installation of her Phalanx close-in weapon system and advanced communications systems, the ship sailed for the United States again in August to carry out the first embarkation of the UK-owned F-35Bs of the Royal Air Force's 617 Squadron. Exercise Westlant 2019 also saw the first carrier battlegroup deployment by the Royal Navy in a decade since the retirement of the Invincible-class carriers.

During the first half of 2020, HMS *Queen Elizabeth* carried out two training cruises in UK home waters to allow more F-35B pilots of 617 Squadron and the operational conversion unit, 207 Squadron, to practice deck operations.

In the autumn of 2020, the ship embarked a squadron of US Marine Corps F-35Bs as well as aircraft from 617 Squadron before joining the Exercise Joint Warrior naval wargames off Scotland. This exercise was a dress rehearsal for the ships deployment to the Mediterranean, Indian Ocean, and Pacific region in the summer of 2021.

Ahead of this deployment, the Royal Navy formally declared the ship's initial operating capability on January 4, 2021. A few days later the Ministry of Defence announced that as well as embarking the USMC F-35B squadron, the HMS *Queen Elizabeth* would be accompanied by a US Navy Arleigh-Burke-class destroyer, the USS *The Sullivans,* during the Carrier Strike Group 21 deployment to the Far East.

| TAILORED AIR GROUP, EXERCISE JOINT WARRIOR SEPT/OCT 2020 | | | |
|---|---|---|---|
| UNIT | AIRCRAFT | ROLE | NUMBER |
| 617 Squadron, RAF | F-35 Lightning II | Strike | 4 |
| VMFA 211, USMC | F-35 Lightning II | Strike | 10 |
| 820 Naval Air Squadron, RN | Merlin HM2 | ASW/COD | 4 |
| 824 Naval Air Squadron, RN | Merlin HM2 | ASW/COD | 2 |

**LEFT: Merlin HMA2 Merlin helicopters are a core part of the HMS *Queen Elizabeth* air group.** (MOD/CROWN COPYRIGHT)

# HMS *Prince of Wales* (RO9)

## Conventionally Powered Aircraft Carrier

**BELOW: HMS *Prince of Wales* was floated out of Rosyth dockyard in September 2019.** (MOD/CROWN COPYRIGHT)

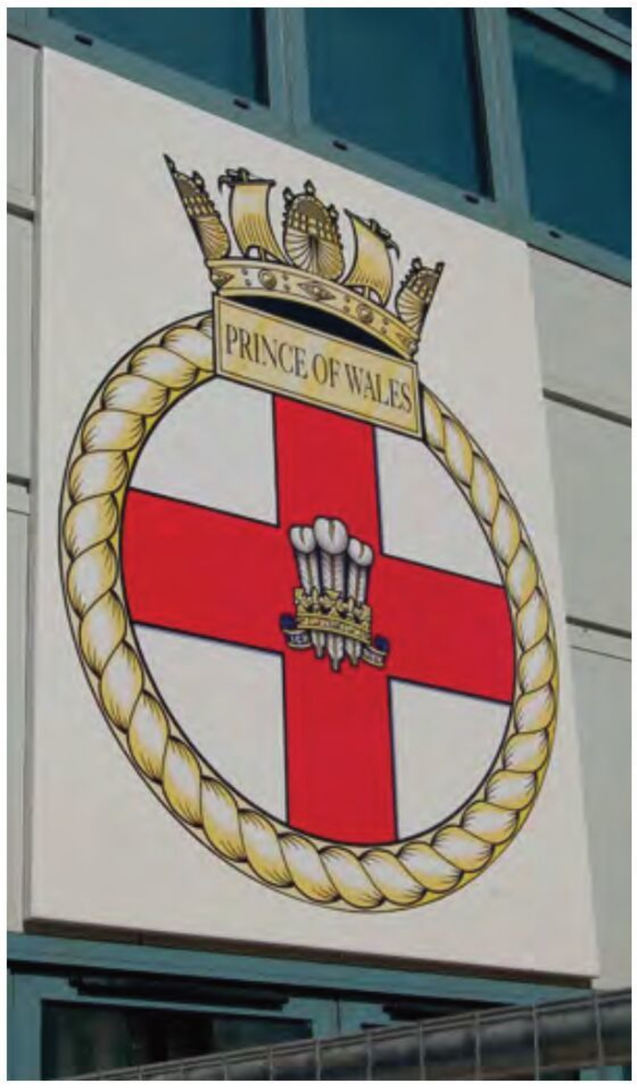
The sister ship of HMS *Queen Elizabeth* is named after the World War Two battleship HMS *Prince of Wales*, which was famously sunk off the coast of Malaya in December 1941 by Japanese torpedo bombers. She is the eighth Royal Navy warship to bear the name. It is the title traditionally given to the heir apparent to the British monarchy.

Since the sinking of the previous HMS *Prince of Wales* no vessels have carried the name, such was the shock caused the sinking of the battleship in the dark days before the fall of Britain's imperial bastion of Singapore.

The Queen Elizabeth-class carriers were built deliberately as a pair so that one of the two ships would always be ready for operations. HMS *Prince of Wales* was built to the same basic design as HMS *Queen Elizabeth* and was assembled in the same shipyard in Fife, using the same modular construction process.

Work on HMS *Prince of Wales* began in May 2011 with the first steel being cut at BAE Systems Govan shipyard in Glasgow. The first blocks arrived at Babcock's Rosyth yard in September 2014 and then assembly accelerated until she was floated out of the dry dock into the basin towards the end of 2017 to allow final fitting out.

She was ready to sail on September 29, 2019 and passed out of the basin into the Firth of Forth to begin her contractors sea trials. Once the carrier arrived at HM Naval Base Portsmouth she was formally commissioned into the Royal Navy. In February 2020, the ship made a week-long visit to the port of Liverpool and hosted thousands of visitors on board in a major exercise in public engagement.



**TOP LEFT:** **The carrier adopted the insignia of the heir to the British throne as its ship's badge.** (TIM RIPLEY)

**ABOVE:** **Hull blocks from several shipyards were brought to Rosyth to be assembled as HMS *Prince of Wales*.** (MOD/CROWN COPYRIGHT)

**BELOW:** **The bridge of HMS *Prince of Wales* sports her name plate and R09 pennant number.** (TIM RIPLEY)

| QUEEN ELIZABETH-CLASS |
|---|
| **Displacement:** 65,000 tons |
| **Length:** 280 m (920 ft) |
| **Beam:** 73 m (240 ft) |
| **Draught:** 11 metres |
| **Speed:** 25 kts (46 km/h) |
| **Capacity:** 1,600, of which 679 are usually the ship's crew |
| **Armament:** Three Phalanx CIWS, four 30mm DS30M Mk2 guns and six mini-guns |
| **Aircraft carried:** 40 aircraft and helicopters (65+ aircraft surge capacity) |

A few weeks later, in May, HMS *Prince of Wales* suffered the first of two floodings in her engine room. Although the Royal Navy described the first damage as minor, the second flood in October caused major damage to electrical cabling and the electrical generator that transferred power to her propellers. By the end of 2020, the damage was revealed as being serious and led to the carrier's deployment to the east coast of the US for F-35B Lightning jump jet trials to be cancelled indefinitely. The repairs to the engines were expected to last at least six months. It was also revealed that the ship only spent 30 days at sea in total during 2020.

Ever since work began on HMS *Prince of Wales* the ship has been under threat of cancellation on cost grounds. The ship survived the 2010 UK defence review but only on with the proviso that a full decision on bringing her into service would be put off to a later date. Once completed the carrier was to be placed in temporary storage. The defence review had committed the Royal Navy to fitting electro-magnetic catapults and arrestor hooks to allow the Queen Elizabeth-class carriers to operate the arrestor hook-fitted version of the Lightning, the F-35C. As work on HMS *Queen Elizabeth* was too far advanced it was intended that HMS *Prince of Wales* would be the first to the first to be fitted with the electro-magnetic catapult until her sister ship could be retro-fitted during her first major refit at some point in the future. These plans were thrown into turmoil in 2012 when cost overruns and technical delays to the US-made Electro Magnetic Launch Systems, known as EMALS, forced the Ministry of Defence to cancel the project and complete the HMS *Prince of Wales* with a ski jump so she could operate the F-35B.

The UK's 2015 defence review reversed the position of the previous review and the Royal Navy was committed to operating HMS *Prince of Wales* alongside her sister ship, either as a strike carrier or in the amphibious assault role with transport helicopters and Royal Marines embarked. After her flooded engine room and delays to her F-35B flight trials there has been speculation that the Royal Navy would put back bringing the carrier on line for two or three years and delay her full work-up as part of a new round of cost savings.

| PROJECTED TAILORED AIR GROUP 2022 | | | |
|---|---|---|---|
| UNIT | AIRCRAFT | ROLE | NUMBER |
| 617 Squadron, RAF | F-35 Lightning II | Strike | 12 |
| 820/814 Naval Air Squadron, RN | Merlin HM2 | ASW/AEW | 8 |
| 845 Naval Air Squadron, RN | Merlin HC4 | COD/CSAR | 4 |
| 815 Naval Air Squadron, RN | Wildcat HM2 | Attack | 2 |

# USS *Nimitz* (CVN-68)

## Nuclear-Powered Aircraft Carrier

**RIGHT: RH-53D helicopters launched from the USS *Nimitz* in April 1980 on the ill-fated mission to rescue American hostages held in Iran.** (US NAVY)

The USS *Nimitz* is named after the World War Two Pacific Fleet commander, Chester W Nimitz, who played a leading role in defeating the Imperial Japanese Navy. He was the overall US Navy commander during the critical Battle of Midway, which turned the tide against the Japanese in the Pacific theatre. Midway was the first strategically important battle fought between carrier fleets so it was fitting that the largest carriers ever built by the US Navy – or any other navy – should have been named after the famous admiral.

| NIMITZ-CLASS |
| --- |
| **Displacement:** 100,020 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 ft (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines and four shafts |
| **Speed:** 31.5 kts (58.3 km/h; 36.2 mph) |
| **Complement:** Ship's company of 3,532 and air wing of 2,480 |
| **Armament:** Two Sea Sparrow, two RIM-116 Rolling Airframe Missile, two Phalanx CIWS, Four Mk 38 25mm auto-cannon turrets, 10 0.50 cal turret emplacements |
| **Aircraft carried:** 90 fixed wing and helicopters |

At just over 100,000 tons the USS *Nimitz* was the biggest warship in the US Navy when she entered service in May 1975, but subsequent ships of the class ended up being larger due to modifications to their design.

The designers of the Nimitz-class learnt many lessons from the construction of the US Navy's first nuclear-powered aircraft carrier, the USS *Enterprise*. The new ships had only two reactors, compared to eight on the *Enterprise*. This saved considerable amounts of space that allowed more aviation fuel and ordnance to be carried than previous carriers. It also reduced the number of personnel needed to keep the reactors operating safely and simplified refuelling. Although the layout of the ship, with its angled flight deck and single island, owed much to the 1960s era carriers, the Nimitz-class boasted additional armour protection around the hangars to prevent the spread of fire

**BELOW: The USS *Nimitz* was the first aircraft carrier of this iconic class of warships.** (US NAVY)

**LEFT: An air wing of more than 70 aircraft can be embarked in the USS *Nimitz*.** (US NAVY)

following enemy attack or accidents. As a result of experience during the Vietnam War, internal design of the ships was improved to enhance the efficiency of moving ordnance up to the flight deck and maintaining aircraft in the hangar deck.

The USS *Nimitz* entered service within weeks of the US evacuation from Saigon so was the first carrier of that era never to have seen service in South East Asia. She spent the first years of her service patrolling the Mediterranean as part of the Sixth Fleet during the height of the Cold War confrontation with the Soviet Union.

In 1980 she was at the centre of the US confrontation with the new revolutionary government in Iran after US diplomats were taken hostage in Tehran. US President Jimmy Carter ordered that a rescue mission be prepared, and the *Nimitz* became the launch pad for the operation. Eight US Navy RH-53D Sea Stallion mine-sweeping helicopters were embarked on the *Nimitz* for the operation because they had the longest range of any US military helicopter at the time. The ill-fated raid was launched on April 24, 1980 with the helicopters flown by experienced US Marine Corps crews. They were to meet up with the assault force that was being flown in by fixed wing aircraft at a refuelling point code-named Desert One.

Confusion and a dust cloud at the refuelling point led to one of the helicopters crashing into the C-130 Hercules aircraft carrying the US Army Delta Force assault force. Eight US personnel were killed in the accident. The operation was cancelled, and the assault force was withdrawn, leaving all the helicopters behind.

In 1981 the USS *Nimitz* was on patrol off Libya when her F-14 Tomcats intercepted two Libyan Su-22 jets and shot them down.

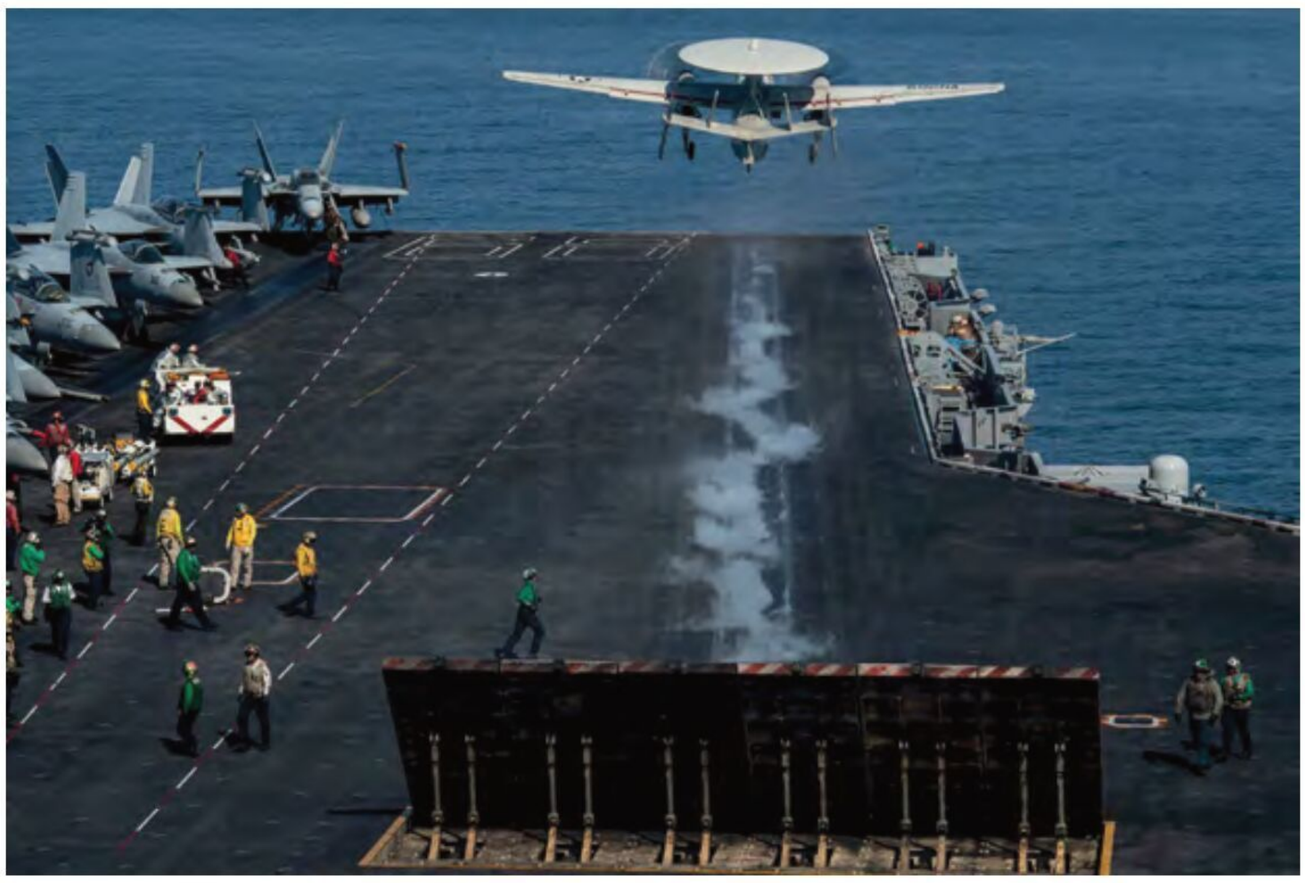
During the 1990s the ship participated in Operation South Watch, deploying aircraft on no fly patrols over Iraq. She continued operations in the Middle East during the 2000s supporting US troops in Iraq and Afghanistan.

| CARRIER AIR WING 17 | | | |
|---|---|---|---|
| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
| F/A-18F | 12 | Strike | VFA-22, USN |
| F/A-18E | 12 | Strike | VFA-94, USN |
| F/A-18E | 12 | Strike | VFA-137, USN |
| F/A-18C | 10 | Strike | VFMA-323, USMC |
| EA-18G | 5 | EW/SEAD | VAQ-139, USN |
| E-2C 2000NP | 4 | AEW | VAW-116, USN |
| MH-60R | 11 | ASW/CSAR/Utility | HSM-73, USN |
| MH-60S | 8 | utility/CSAR | HSC-6, USN |
| C-2A | 2 | COD | VRC-30 Det 1, USN |

In 2012, the *Nimitz* carried out on-board delivery, or COD, trials involving the V-22 Osprey to examine if the new tiltrotor could replace the veteran C-2 Greyhound in that important role. Two years later, trials of the new F-35C Lightning took place on the ship.

Instability in the Middle East led to the *Nimitz* returning in 2017 to launch her aircraft on strike missions against Islamic State fighters in Iraq and Syria.

The ship's nuclear reactors were intended to go 20 years between refuelling's and the ship has a projected service life of 50 years. It had been intended that the USS *Nimitz* would retire in 2022 when the USS *John F Kennedy* was supposed to be ready to join the fleet. However, construction delays and technical problems with the Gerald R Ford-class carriers have put these plans in question and the *Nimitz* may have to stay in service beyond her planned retirement date.



**LEFT: An E-2 Hawkeye lifts off from USS *Nimitz* past a line of F/A-18 Hornet fighter jets.** (US NAVY)

# USS *Dwight D Eisenhower* (CVN-69)

## Nuclear-Powered Aircraft Carrier

The angled flight deck of the USS *Dwight D Eisenhower* is the distinctive feature of Nimitz-class aircraft carriers. (US NAVY)

The USS *Dwight D Eisenhower* is the second Nimitz-class aircraft carrier and is named after the famous World War Two allied supreme commander in Europe who later became US president. Like her namesake, the carrier is known around the fleet as 'Ike'. She was originally to be named the USS *Eisenhower* but during construction the name was changed to its current form.

Like all the other Nimitz-class vessels, she was built in Newport News in Virginia. The USS *Dwight D Eisenhower* was built to the same configuration as the first of class, USS *Nimitz*. She cost $679 million to build which is the equivalent of more than $4 billion in 2021 prices.

The USS *Dwight D Eisenhower* was assigned to the US Atlantic Fleet after she entered service in 1979 and was soon conducting regular patrols in the Mediterranean amid growing tension with Libya and in Lebanon. Her aircraft duelled with Libyan jets in 1983 and late in that cruise, USS *Dwight D Eisenhower* deployed off Lebanon when US peacekeeping troops came under attack. In both 1984 and 1994, the USS *Dwight D Eisenhower* participated in events to mark the anniversary of the D-Day landings in Normandy, which were planned and commanded by General Eisenhower.

| NIMITZ-CLASS |
|---|
| **Displacement:** 100,020 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 ft (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines and four shafts |
| **Speed:** 31.5 kts (58.3 km/h; 36.2 mph) |
| **Complement:** Ship's company of 3,532 and air wing of 2,480 |
| **Armament:** Two Sea Sparrow, two RIM-116 Rolling Airframe Missile, two Phalanx CIWS, Four Mk 38 25mm auto-cannon turrets, 10 0.50 cal turret emplacements |
| **Aircraft carried:** 90 fixed wing and helicopters |

While on patrol in the Mediterranean in the summer of 1990, the USS *Dwight D Eisenhower* was mobilised to respond to the Iraqi invasion of Kuwait. She was famously filmed transiting the Suez Canal in the first wave of Operation Desert Shield before eventually returning home in the days ahead of the formal start of the conflict with Iraqi in January 1991.

When political unrest engulfed Haiti in 1994, the USS *Dwight D Eisenhower* was mobilised to transport troops and helicopters of the 10th Mountain Division to the Caribbean island. At short notice, the ship's air group was disembarked to make room for US Army soldiers and their UH-60 Blackhawk and AH-1 Cobra helicopters. As the 'Ike' sailed toward Haiti, plans were made to launch an air assault from the carrier's deck to capture key points in the island, but the military junta and their troops fled as the soon as the ship came within range. The troops were flown ashore unopposed to restore the island's democratically elected government.

Late in 1994 the ship deployed to the Middle East to help enforce the no fly zones over Iraq and made history because, for the first time she embarked a contingent of female sailors on a US Navy combatant. Some 400 female sailors were embarked on the ship. At the time, the role of female sailors on the vessel came under intense scrutiny but it is now routine for female crew members to serve on US Navy aircraft carriers and other warships.

During the 2000s, the USS *Dwight D Eisenhower* was deployed to the Middle East on several occasions, to launch aircraft on strike missions to support US troops occupying Iraq and coalition forces in Afghanistan. In 2007 she supported US air operations against targets in Somalia. Two years later she became the first US aircraft carrier to pull alongside in Bahrain's Manama naval base since 1948 and was the largest-ever US warship to dock in the Gulf port.

| CARRIER AIR WING 3 | | | |
|---|---|---|---|
| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
| F/A-18F | 12 | Strike | VFA-32, USN |
| F/A-18E | 12 | Strike | VFA-83, USN |
| F/A-18E | 12 | Strike | VFA-105, USN |
| F/A-18E | 12 | Strike | VFA-131, USN |
| EA-18G | 5 | EW/SEAD | VAQ-130, USN |
| E-2C 2000NP | 4 | AEW | VAW-123 USN |
| MH-60R | 11 | ASW/Strike | HSM-74, USN |
| MH-60S | 8 | utility/CSAR | HSC-7, USN |
| C-2A NP | 2 | COD | VRC-40 Det 4, USN |

The carrier's aircraft were in action in Iraq and Syria in 2016, striking Islamic State targets from both the Mediterranean and the Arabian Gulf and dropping some 1,100 bombs in action. Four years later, the ship returned to the Mediterranean and Arabian Gulf again, remaining at sea for the longest time in US Navy history, more than 161 days, to avoid the risk of the crew bringing the COVID-19 virus onboard during port visits.

US Navy plans currently envisage the ship remaining in service until 2029 when she is expected to be replaced by the new USS *Enterprise*. Work has already begun on the new carrier in the Newport News yard but there is considerable uncertainty about the entry to service of Gerald R Ford-class carriers, so the USS *Dwight D Eisenhower* might have to be extended in service.

**ABOVE: The USS *Dwight D Eisenhower* is named after the famous US general and president, who was popularly known as 'Ike'. Like her namesake, the carrier is routinely referred to as Ike.** (US NAVY)

**BELOW LEFT: In 1994 the carrier's air wing was replaced by US Army helicopters for the Operation Uphold Democracy in Haiti.** (US NAVY)

**BELOW RIGHT: A F-35C takes off from the USS *Dwight D Eisenhower* during the jet's trials.** (US NAVY)

# USS *Carl Vinson* (CVN-70)

## Nuclear-Powered Aircraft Carrier

**ABOVE: The bow view of USS *Carl Vinson* shows off her massive flight deck.** (US NAVY)

The USS *Carl Vinson* is named after the long-serving member of the US House of Representatives who, during his 50 years in office up to1965, strongly backed the building of US Navy warships. He was instrumental in kick-starting US warship building before World War Two with the Two Ocean Navy Act and as chair of the House Armed Service Committee authorised the building of the first nuclear-powered aircraft carrier, the USS *Enterprise*. In his 90th year he was invited to the launch of the USS *Carl Vinson,* making him the first living person to see a US Navy warship named in his honour. She is known in the US Navy as the 'Chuck Wagon'.

After being commissioned in 1982, USS *Carl Vinson* joined the Pacific Fleet and operated from her home port of San Diego across the Western Pacific region for the remainder of the decade. In 1988 she was dispatched to the Middle East to help escort US-flagged oil tankers under Iranian and Iraqi attack.

The carrier missed the 1991 Gulf war because she was undergoing a 28-month overhaul. But she was back in action and led a naval task force into the Arabian Gulf in 1994 to help enforce the no fly zone over Iraq. She returned to the Gulf in 1996 for strike operations against the country. Operation Desert Strike involved the USS *Carl Vinson's* F-14s Tomcats escorting USAF B-52 bombers approaching Iraq for the attack.

In the aftermath of the 9/11 attacks on New York and Washington DC in September 2001, the USS *Carl Vinson* was ordered to steam at full speed for the coast of Pakistan and she arrived in time to join the first wave of air strikes against Taliban and Al Qaeda targets in Afghanistan on October 7.

She stayed on station in the Indian Ocean for 72 days, launching her aircraft on a daily basis to support US special forces teams on the ground with anti-Taliban militia units. In just under two months, the Taliban had been defeated and US troops had established bases ashore in the central Asian country. By the time USS *Carl Vinson* was pulled out of the line in December, her air wing had flown more than 4,000 missions.

The carrier was not called on to participate in the 2003 invasion of Iraq, but she put to sea for nine months with her battle group to backfill for Pacific Fleet warships re-deployed to the Middle East.

**LEFT: F-35Cs will be embarked on the USS *Carl Vinson* for the first ever routine squadron deployment.** (US NAVY)

**BELOW: The USS *Carl Vinson* undertakes replenishment at sea.** (US NAVY)

**BOTTOM: Flight operations underway from the USS *Carl Vinson*.** (US NAVY)

The *Carl Vinson* returned to the Middle East in 2005 to support US troops fighting in Iraq and Afghanistan. After a major refuelling, she returned to the fleet in 2009 and soon afterwards was leading a humanitarian task force to help Haiti recover from a devastating earthquake in January 2010.

The following year, the carrier was on duty in the Northern Arabian Sea when US Navy SEALs carried out a raid into Pakistan to kill or capture the Al Qaeda chief Osama Bin Laden. After the raid, Bin Laden's body was flown out to the USS *Carl Vinson* to be buried at sea.

In early 2015, the carrier was back in the Arabian Gulf supporting coalition forces fighting Islamic State militants in Iraq and Syria. War was at a peak of intensity with the ship's air wing flying 2,382 combat missions and dropping more than 230 tons of bombs.

She returned home in the summer of 2015 and began a $300 million upgrade that included the installation of the first control centre for unmanned aerial vehicles.

The carrier returned to the Pacific in 2017 and was at the centre of a diplomatic crisis with North Korea and in 2018 made a port visit to Vietnam during a state visit to the country by US President Donald Trump.

| NIMITZ-CLASS |
|---|
| **Displacement:** 100,020 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 ft (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines and four shafts |
| **Speed:** 31.5 kts (58.3 km/h; 36.2 mph) |
| **Complement:** Ship's company of 3,532 and air wing of 2,480 |
| **Armament:** Two Sea Sparrow, two RIM-116 Rolling Airframe Missile, two Phalanx CIWS, Four Mk 38 25mm auto-cannon turrets, 10 0.50 cal turret emplacements |
| **Aircraft carried:** 90 fixed wing and helicopters |

| CARRIER AIR WING 2 | | | |
|---|---|---|---|
| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
| F/A-18F | 12 | Strike | VFA-2, USN |
| F/A-18E | 12 | Strike | VFA-113, USN |
| F-35C | 12 | Strike | VFA-147, USN |
| F/A-18E | 12 | Strike | VFA-192, USN |
| EA-18G | 5 | EW/SEAD | VAQ-136, USN |
| E-2D | 4 | AEW | VAW-113, USN |
| MH-60R | 11 | ASW/Strike | HSM-78, USN |
| MH-60S | 8 | utility/CSAR | HSC-4, USN |
| CMV-22B | | COD | VRM-30, USN |

# USS *Theodore Roosevelt* (CVN-71)

## Nuclear-Powered Aircraft Carrier

**BELOW: An F/A-18 Hornet launched from the forward catapult of USS *Theodore Roosevelt.*** (US NAVY)

The USS *Theodore Roosevelt* is the fourth Nimitz-class aircraft carrier and is named after the 26th president of the United States. She is the fourth ship to bear the name Roosevelt and the third to bear his full name. Roosevelt was an exponent of US naval power who coined the phrase, "speak softly and carry a big stick; you will go far." He led a cavalry unit, nicknamed the 'Rough Riders', during the 1898 American-Cuban war and the USS *Theodore Roosevelt* has adopted the radio call sign 'Rough Rider' in their honour.

**CARRIER AIR WING 11**

| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
|---|---|---|---|
| F/A-18E | 12 | Strike | VFA-31, USN |
| F/A-18E | 12 | Strike | VFA-87, USN |
| F/A-18E | 12 | Strike | VFA-146, USN |
| F/A-18F | 12 | Strike | VFA-154, USN |
| EA-18G | 5 | EW/SEAD | VAQ-142, USN |
| E-2C 2000NP | 4 | AEW | VAW-115, USN |
| MH-60R | 11 | ASW/Strike | HSM-75, USN |
| MH-60S | 8 | utility/CSAR | HSC-8, USN |
| C-2A | 2 | COD | VRC-30 Det 3, USN |

Structural improvements, including enhancements to the protection of the ship's ordnance storage magazines, added nearly 5,000 tons to the weight of the USS *Theodore Roosevelt,* which were also incorporated into subsequent ships of the Nimitz class. The ship and the subsequent four vessels were known as the Theodore Roosevelt sub-class.

The USS *Theodore Roosevelt* was also the first Nimitz-class ship to be built using modular assembly techniques. This cut some 16 months off the time taken to construct the ship and these techniques were used in the assembly of subsequent US aircraft carriers.

The USS *Theodore Roosevelt* sailed on her first operational cruise to the Mediterranean in December 1988. Two years later she joined the build-up of forces for Operation Desert Storm in the Arabian Gulf and arrived in time for the start of the war in January 1991. Eventually six US aircraft carriers were launching aircraft against Iraq in the biggest show of naval air power since the Vietnam War.

Operating from the Arabian Gulf, USS *Theodore Roosevelt's* air group was in the forefront of coalition air strikes against the Iraqi army in Kuwait and the Iraqi navy protecting the coast of the occupied emirate. During the six week-long war the aircraft of the carrier's air wing flew some 4,200 sorties and dropped more than two million kilograms of bombs. After the war, the carrier re-deployed to the Mediterranean to fly air support to the humanitarian mission to protect Kurdish refugees in northern Iraq. The carrier subsequently returned home to Norfolk, Virginia in June 1991 after spending 189 days at sea.

Over the next decade, the *Theodore Roosevelt* became the mainstay of Sixth Fleet operations in the Mediterranean. In 1993 her aircraft helped establish the UN-mandated no fly zone over Bosnia and for this cruise the carrier embarked a task force of US Marines configured for combat search and rescue missions. Two years later the carrier's air group spearheaded the NATO air offensive code-named Operation Deliberate Force against Serb forces in the Balkan country.

In 1999, the USS *Theodore Roosevelt* was again in action over the Balkans with her aircraft playing a leading role in NATO's Operation Allied Force, striking at targets in Kosovo and Serbia.

**LEFT: The USS *Theodore Roosevelt* docks at the US Pacific island of Guam during the 2002 Covid 19 crisis.** (US NAVY)

After the 9/11 attacks on Washington and New York, the *Theodore Roosevelt* was scrambled to reinforce the US Navy fleet in the North Arabian Sea in preparation for offensive operations against Afghanistan. She arrived on station on October 15, 2001 and her aircraft immediately began striking at targets in Afghanistan. She pulled into Bahrain for a port call, after spending 160 consecutive days at sea, then a record for an American aircraft carrier since World War Two.

When US forces began attacking Iraq in March 2003 to overthrow Saddam Hussein's government, the USS *Theodore Roosevelt* joined the offensive in the Mediterranean with her aircraft flying repeated missions. The carrier returned to support US troops in Iraq in 2006 and to support coalition troops in Afghanistan in 2008. During the later cruise, the ship's air wing flew 3,100 sorties over Afghanistan and dropped more than 59,500 pounds of ordnance.

| NIMITZ-CLASS (THEODORE ROOSEVELT SUB-CLASS) |
|---|
| **Displacement:** 104,600 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 feet (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines driving four shafts |
| **Speed:** 30+ kts (56+ km/h; 35+ mph) |
| **Complement:** Ship's company of 3,200 and 2,480 air wing personnel |
| **Armament:** Two Sea Sparrow, Two RIM-116 Rolling Airframe Missile, Two Phalanx CIWS |
| **Aircraft carried:** 90 fixed wing and helicopters |

In 2015 the USS *Theodore Roosevelt* relocated her home port from Norfolk to San Diego in California, via an operational deployment to the Middle East that in effect saw the carrier sail 50,000 kilometres to circumnavigate the globe. During the deployment, her aircraft flew 1,800 combat sorties against Islamic State targets in Iraq and Syria and dropped 1,085 guided munitions.

While operating in the West Pacific in the spring of 2020 the carrier was hit by a major outbreak of the COVID-19 virus that left 585 sailors infected. One subsequently died. The ship's captain was relieved of his command in the aftermath of the outbreak.

**ABOVE: Hornet heaven. USS *Theodore Roosevelt's* flight deck packed with F/A-18 jets.** (US NAVY)

**LEFT: USS *Theodore Roosevelt* underway in the North Atlantic.** (US NAVY)

# USS *Abraham Lincoln* (CVN-72)

## Nuclear-Powered Aircraft Carrier

**MAIN PICTURE:** **USS *Abraham Lincoln*, in the foreground, cruises with the USS *John C Stennis*.** (US NAVY)

The USS *Abraham Lincoln* is named after the famous Civil War-era president and is the second US Navy vessel to bear his name. The other USS *Abraham Lincoln* was a George Washington-class nuclear-powered ballistic missile firing submarine. Not surprisingly, the carrier is nicknamed 'Abe' after President Abraham Lincoln who was known colloquially as 'Honest Abe'.

| CARRIER AIR WING 9 | | | |
|---|---|---|---|
| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
| F/A-18E | 12 | Strike | VFA-14, USN |
| F/A-18F | 12 | Strike | VFA-41, USN |
| F/A-18E | 11 | Strike | VFA-151, USN |
| F-35C | 12 | Strike | VFMA-314, USMC |
| EA-18G | 5 | EW/SEAD | VAQ-133, USN |
| E-2D | 4 | AEW | VAW-117, USN |
| MH-60R | 11 | ASW/Strike | HSM-71, USN |
| MH-60S | 8 | utility/CSAR | HSC-14, USN |
| C-2A | 2 | COD | VRC-30 Det 4, USN |

After work-up deployment to South America in 1990 en route to her home port in San Diego, California, the USS *Abraham Lincoln* undertook her first operational cruise to the Middle East in the spring of 1991 to relieve the aircraft carriers that had participated in Operation Desert Storm.

En route across the Pacific, the carrier and her battle group were diverted to assist the evacuation of the US naval base at Subic Bay in the Philippines after the volcano Mount Pinatubo erupted. This was the largest peacetime evacuation of US military personnel and civilians. Once this mission was complete, she continued on her cruise to the Arabian Gulf.

Another cruise to the region followed in 1993 to support US and United Nations troops on humanitarian duty in Somalia as part of Operation Restore Hope and in 1994, the USS *Abraham Lincoln* became the first Pacific Fleet carrier to embark female naval aviators in its air wing.

While on patrol in the Indian Ocean and Arabian Gulf in 1995 the USS *Abraham Lincoln* was diverted to support a build-up of US troops in Kuwait after Iraqi forces were detected massing closing to the Gulf emirate. The show of force, dubbed Operation Vigilant Sentinel, resulted in the Iraqi troops returning to their barracks.

In June 1998, in response to Al Qaeda bomb attacks on US embassies in Kenya and Tanzania, the *Abraham Lincoln* battle group was ordered to launch a Tomahawk cruise missile attack on a pharmaceutical factory in the Sudanese capital Khartoum and training camps in Afghanistan linked to the group's leader Osama Bin Laden. The carrier's aircraft did not participate in the strikes, but the missile attacks were co-ordinated from her command centre.

The carrier put to sea again in July 2002 to head to the Arabian Gulf to help support US troops in Afghanistan and to enforce the no fly zone over southern Iraq. As tension grew with Iraq in the spring

| NIMITZ-CLASS (THEODORE ROOSEVELT SUB-CLASS) |
|---|
| **Displacement:** 104,600 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 feet (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines driving four shafts |
| **Speed:** 30+ kts (56+ km/h; 35+ mph) |
| **Complement:** Ship's company of 3,200 and 2,480 air wing personnel |
| **Armament:** Two Sea Sparrow, Two RIM-116 Rolling Airframe Missile, Two Phalanx CIWS |
| **Aircraft carried:** 90 fixed wing and helicopters |

of 2003, the carrier's return to port was cancelled and she remained on duty in the region during the US-led invasion. Her air wing flew some 16,500 sorties during the deployment and dropped some 1.6 million pounds of ordnance. She spent 290 days deployed, which was a record for US Navy aircraft carriers until 2020.

The ship achieved fame when US President George W Bush flew onto the USS *Abraham Lincoln* as she approached her home port at San Diego in May 2003 and made a televised speech. A banner declaring 'mission accomplished' was photographed hanging below the ship's bridge. The event was considered misjudged because US troops remained in Iraq for another eight years and suffered 4,424 deaths and 31,952 wounded in action.

In December 2004, the carrier was diverted to Indonesia to assist in the humanitarian relief effort after a tsunami struck the island nation. The ship's helicopters flew 1,747 aid missions and crew members went ashore to assist in rescue and recovery operations. For the remainder of the decade the ship operated in the Pacific region and underwent modernisation.

After an operational cruise to the Middle East in 2012, the carrier returned direct to Norfolk naval base ahead of a major refuelling period. This was delayed by a more than a month because of the shutdown of the US Federal government. Work only got underway at Newport News in March 2013 and the ship remained out of action until 2017 when she was returned to the fleet. And in August of the following year, F-35C Lightning aircraft carried out operational test flights onto the carrier.

On April 1, 2019, the USS *Abraham Lincoln* sailed for the Mediterranean and later in the year headed through the Suez Canal to begin operating in the Indian Ocean. Her return home was delayed after sister ship, the USS *Harry S Truman* suffered electrical problems. Eventually 'Abe' was released from duty to head to her home port at San Diego, arriving on January 20, 2021 after 295 days at sea, a new record for a US Navy aircraft carrier.

**LEFT: CVN-72 at sea with her air wing embarked.** (US NAVY)

**LEFT: An F/A-18 Hornet parked on the rear flight deck of the USS *Abraham Lincoln*.** (US NAVY)

**BELOW: The cruiser USS *Leyte Gulf* protects the USS *Abraham Lincoln*.** (US NAVY)

# USS *George Washington* (CVN-73)

## Nuclear-Powered Aircraft Carrier

**BELOW: Sunset over the USS *George Washington*.** (US NAVY)

The USS *George Washington* is the fourth US Navy ship to bear the name of the commander of the American army during the War of Independence against Britain and the first president of the newly established republic. She is known around the fleet as 'GW'.

Improvements in the ship design were incorporated during her construction including upgraded flight deck protection.

After being commissioned into the US Navy in 1992, the USS *George Washington* under took her maiden voyage in 1994, which include a period in the Adriatic Sea when her air group took part in no fly zone patrols over Bosnia. She later continued her cruise to the Arabian Gulf where she flew missions during Operation Vigilant Warrior in response to Iraqi troop movements threatening Kuwait.

Further cruises to the Mediterranean and Gulf regions were made in 1996 and 1997. The tempo of operations in the southern Iraq no fly zones stepped up by the time the USS *George Washington* returned to the Gulf in 2000, which saw the ship's air wing fly 800 sorties over Iraq.

In the wake of the 9/11 attacks on Washington and New York in 2001, the carrier put to sea to fly air security patrols along the American east coast under the banner of Operation Noble Eagle. During this mission, the carrier's aircraft flew 234 sorties. Returning to the Middle East in the summer of 2002 the *George Washington* strike aircraft flew 925 missions over Afghanistan.

She sailed for the Middle East in early 2004 as the Iraq insurgency was gathering momentum and subsequently her aircraft flew close air support missions for US Marines fighting in the city of Fallujah.

In 2008, while sailing around South America en route to Japan where she was to be forward based, the carrier suffered a serious fire in her refrigeration and air conditioning compartments that lasted for 12 hours and resulted in 37 sailors being injured. The carrier had to put in to San Diego for repairs that cost $70 million. A subsequent investigation revealed that sailors had been smoking in a store room containing flammable compressor oil. The ship's captain and executive officer were relieved of their posts.

The USS *George Washington* arrived at Yokosuka in September 2008 to become the first nuclear-powered aircraft carrier to be permanently home ported in Japan. She then became heavily involved in exercises and diplomatic port visits around the Western Pacific region.

The carrier was in port in Yokosuka in April 2011 when Japan's eastern coast was struck by a tsunami and the Fukushima nuclear power station was damaged. After radiation was detected in Yokosuka, the *George Washington* was ordered to immediately put to sea to avoid becoming contaminated. The ship sailed so quickly that she could only muster a minimal crew and so could not take part in the relief operation around the coast of Japan. Eventually, she had to put into the US naval base at Sasebo to the south of the disaster zone to pick up addition personnel.

Later that year the Pentagon and the US Congress began considering whether to cancel the carrier's mid-life refuelling, which was due in 2016, and retiring the ship 25 years early. This would have saved $3 billion in the cost of the refuel period and much more by cutting short the life of the ship. However, by the end of 2014 the Pentagon had decided to keep the carrier in service. In the meantime, she continued to take part in exercises in the West Pacific in 2015, before relocating to a new home port at Norfolk naval base in Virginia. The ship was called into action in 2016 to lead a relief effort after Haiti was struck by a hurricane.

The USS *George Washington* moved to the dry dock at Newport News in August 2017 to begin her refuel and complex overhaul period. This was scheduled to last four years and cost $7 billion. It currently has no air wing embarked.

**ABOVE: The USS *George Washington* and the Japanese helicopter carrier JS *Hyuga* on exercise.** (US NAVY)

**LEFT: View from the bridge of the USS *George Washington* during flight operations.** (US NAVY)

**LEFT: Royal Malaysian Navy frigates escort the USS *George Washington*.** (US NAVY)

| NIMITZ-CLASS (THEODORE ROOSEVELT SUB-CLASS) |
|---|
| **Displacement:** 104,600 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 feet (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines driving four shafts |
| **Speed:** 30+ kts (56+ km/h; 35+ mph) |
| **Complement:** Ship's company of 3,200 and 2,480 air wing personnel |
| **Armament:** Two Sea Sparrow, Two RIM-116 Rolling Airframe Missile, Two Phalanx CIWS |
| **Aircraft carried:** 90 fixed wing and helicopters |

# USS *John C Stennis* (CVN-74)

## Nuclear-Powered Aircraft Carrier

**MAIN PICTURE:** Helicopter operations from the USS *John C Stennis*. (US NAVY)

The USS *John C Stennis* is the second Nimitz-class aircraft carrier to be named after a senior congressional leader. Stennis was chairman of the Senate Armed Services Committee during the 1980s and had been a long-time proponent of increases in defence spending. In 1988, US President Ronald Reagan announced at a dinner to mark Stennis' retirement from the senate that the next Nimitz-class ship would be named after the senator. Reagan called him "the father of America's modern Navy" due to Stennis' contributions to nuclear research that made important impacts on naval nuclear power. In the late 1970s the then US President Jimmy Carter wanted to cancel the fourth Nimitz-class carrier, but congress and Stennis got the project reinstated in the Pentagon budget.

Stennis' daughter named CVN-94 after her father in 1993. The senator's southern heritage led to CVN-74 being nicknamed 'Johnny Reb' by US sailors, which was the slang term for Civil War-era Confederate soldiers.

For the first time on a Nimitz-class carrier the ship incorporated high strength, low-alloy steel. In the three years after her commissioning, the carrier conducted work-up training and trials off the US east coast from her home port at Norfolk naval base. This included the first ever carrier landing by the then new F/A-18E/F Super Hornet fighter aircraft - which was destined to become the mainstay of US Naval Aviation in the 21st century – on January 18, 1997.

The carrier sailed on her first operational cruise in February 1998 and within the month she was on station in the Arabian Gulf flying no fly zone patrols over southern Iraq. In the autumn she returned home for a maintenance period before returning to duty in the Middle East in January 2000. The ship was mobilised to take part in Operation Noble Eagle after the 9/11 attacks on Washington and New York to launch air security patrols along America's east coast and a few weeks later she sailed for the Middle East to provide air support for US troops fighting in Afghanistan in early 2002.

During 2004 she underwent an upgrade that included the fitting of new masts and radio antenna, as well as a new bridge. The carrier was then placed on alert status, ready for short notice surge deployments. In January 2007 she was alerted to deploy to the Middle

East to support the surge of US troops into Iraq in co-operation with the USS *Dwight D Eisenhower* in a bid to defeat the insurgence once and for all. Her arrival on station in the Arabian Gulf marked the first time since 2003 that the US Navy had positioned two carriers simultaneously on station in the region. The USS *John C Stennis* was on station in the Arabian Gulf in 2011 and flew the last US air support mission over Iraq to cover the final withdrawal of US troops from the country in December 2011. She then switched to supporting counter-piracy patrols off the coast of Somalia.

In 2013 and 2018 the carrier returned to the Indian Ocean to launch her aircraft to support NATO and US troops in Afghanistan. In between these deployments she participated in routine training exercises and port visits around the Pacific region.

Ahead of entering dry dock at Newport News shipyard for her mid-life refuel and complex overhaul, the USS *John C Stennis* tied up at Norfolk naval base in Virginia in 2019. Work began on the refuel in January 2021 and it is expected to take four to five years. The carrier currently has no air wing embarked.

Controversy surrounded the ship in the wake of moves in 2020 to change the name of US military bases linked to the Confederacy during the Civil War. As a result of this there were calls for the USS *John C Stennis* to be re-named as part of a drive to remove Confederate links from modern US military.

As well as being a strong proponent of naval ship building, Senator Stennis represented the southern state of Mississippi and was an active supporter of the segregationist movement in the 1950s and 1960s. He voted repeatedly against civil rights legislation as well as opposing making the birthday of the civil rights activist Dr Martin Luther King a national holiday.

**ABOVE:** **The USS *John C Stennis* is the seventh Nimitz-class aircraft carrier.** (US NAVY)

**LEFT:** **Trainee US Naval Aviators practice catapult take-offs in T-45C Goshawk jets from the USS *John C Stennis*.** (US NAVY)

**BOTTOM LEFT:** **The USS *John C Stennis* and other US Navy carriers routinely embark T-45C Goshawks to train up the next generation of US Naval Aviators.** (US NAVY)

| NIMITZ-CLASS (THEODORE ROOSEVELT SUB-CLASS) |
|---|
| **Displacement:** 104,600 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 feet (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines driving four shafts |
| **Speed:** 30+ kts (56+ km/h; 35+ mph) |
| **Complement:** Ship's company of 3,200 and 2,480 air wing personnel |
| **Armament:** Two Sea Sparrow, Two RIM-116 Rolling Airframe Missile, Two Phalanx CIWS |
| **Aircraft carried:** 90 fixed wing and helicopters |

**RIGHT: Sailors help tie up the USS *Harry S Truman* after her return to Norfolk naval base in June 2020.** (US NAVY)

The USS *Harry S Truman* is named after the president who led the United States in the final year of World War Two and into the Cold War. He ordered the use of atomic weapons against Japan and then began mobilising the US and her allies to confront the Soviet Union in the late 1940s. The ship has adopted the nickname 'Give 'em hell' in honour of the motto carried on the flag of Truman's World War One artillery unit. Its radio callsign - 'Lone Warrior' - is attributed to Truman's famous phrase, "the buck stops here" and the idea of ultimate responsibility residing with the president.

Her construction during the 1990s at Newport News culminated in the ship being commissioned in 1998. She set sail on her maiden operational deployment in November 2000 and early the following year her aircraft began flying patrols over the Iraqi no fly zone. During her cruise, the USS *Harry S Truman* air wing flew 689 sorties over Iraq.

**BELOW: The USS *Harry S Truman* is assigned to the US Atlantic Fleet and routinely deploys to European waters.** (US NAVY)

In December 2002 she set sail for the Mediterranean as part of the build-up for the US-led invasion of Iraq. Between March 19 and April 18, the carrier's aircraft flew just under 1,300 sorties against targets in Iraq from the Mediterranean. These sorties were flown over Turkey and into Northern Iraq to support US special forces troops operating with Kurdish allies. The USS *Harry S Truman* returned to the Middle East in late 2004 as insurgent attacks on US troops in Iraq escalated.

After Hurricane Katrina struck New Orleans in September 2005, the carrier deployed for five weeks to help with the relief effort in the city. The ship returned to the Middle East in 2007 and 2010, and during the later deployment her aircraft flew some 10,000 sorties.

In 2011 the carrier underwent a major upgrade, which included the fitting of new masts, an improved close-in weapon system and a new data network to enhance communications around the ship. During the summer of 2012, the carrier was used for the first ship trials of the experimental X-47B Unmanned Combat Air System

# USS *Harry S Truman* (CVN-75)

## Nuclear-Powered Aircraft Carrier

| NIMITZ-CLASS (THEODORE ROOSEVELT SUB-CLASS) |
|---|
| **Displacement:** 104,600 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 feet (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines driving four shafts |
| **Speed:** 30+ kts (56+ km/h; 35+ mph) |
| **Complement:** Ship's company of 3,200 and 2,480 air wing personnel |
| **Armament:** Two Sea Sparrow, Two RIM-116 Rolling Airframe Missile, Two Phalanx CIWS |
| **Aircraft carried:** 90 fixed wing and helicopters |

(UCAS). These were deck integration and handling trials to assess how the ship's crews could operate the X-47B alongside existing manned aircraft. The revolutionary UCAS was not actually launched off the carrier during this phase of the experiment.

From 2013 the *Harry S Truman* was routinely deployed to the Middle East to support US troops in Afghanistan and Iraq, as well as support counter-piracy operations off the coast of Somalia. She sailed to the region in 2013, 2014, 2015 and 2018. Between December 2015 and April 2016, the carrier's aircraft dropped 1,118 bombs on targets in territory held by the Islamic State group in Iraq and Syria. During its 2015-16 cruise, the carrier launched aircraft on strike missions from both the Arabian Gulf and the Mediterranean. This cruise coincided with growing tension with Iran and during the carrier's transits through the Straits of Hormuz in December 2015 and in January 2016, Iranian forces fired rockets and flew drones near the ship.

The carrier deployed to the Norwegian Sea in 2018 to participate in NATO's Exercise Trident Junction, marking a return of US Navy carriers to this region for the first time since the end of the Cold War in 1990.

In early 2019, the Pentagon proposed that the *Harry S Truman's* refuelling and complex overhaul be cancelled to save the $3.5 billion cost of the four year-long project. This would have meant the ship would have had to be retired by 2025 and the size of the US Navy carrier fleet would have dropped to ten carriers. US President Donald Trump eventually ordered the refuel to go ahead and expressed a desire to increase the size of the carrier force to 12 ships.

The USS *Harry S Truman* was supposed to deploy on another cruise to the Middle East in August when the ship suffered a major electrical fault that delayed her sailing. It took two months to repair the problems and the ship eventually arrived in the Mediterranean in December 2019, which meant the USS *Abraham Lincoln* had to be extended on station until the *Harry S Truman* arrived.

**ABOVE: En route to the Arabian Gulf, the USS *Harry S Truman* passes through the Suez Canal.** (US NAVY)

**LEFT: Escort vessels always accompany the USS *Harry S Truman* on operational deployments.** (US NAVY)

| CARRIER AIR WING 9 | | | |
|---|---|---|---|
| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
| F/A-18E | 12 | Strike | VFA-11, USN |
| F/A-18E | 12 | Strike | VFA-81, USN |
| F/A-18E | 12 | Strike | VFA-34, USN |
| F/A-18F | 12 | Strike | VFA-211, USN |
| EA-18G | 5 | EW/SEAD | VAQ-137, USN |
| E-2D | 4 | AEW | VAW-126, USN |
| MH-60R | 11 | ASW/Strike | HSM-72, USN |
| MH-60S | 8 | utility/CSAR | HSC 11, USN |
| C-2A | 2 | COD | VRC-40 Det 1, USN |

# USS *Ronald Reagan* (CVN-76)

## Nuclear-Powered Aircraft Carrier

**RIGHT: E-2 Hawkeyes on the USS *Ronald Reagan* as flight operations are underway.** (US NAVY)

The USS *Ronald Reagan* is named after the United States president between 1981 and 1989. She is unofficially known in the US Navy as 'The Gipper' in honour of Reagan's nickname earned during his acting career. The ship was the first to be named after a living former President.

So many improvements were incorporated in her design that she was designated as the lead ship of a sub-class of the Nimitz-class carriers. These improvements include a bulbous bow to improve speed and fuel efficiency by reducing wave-making resistance, the installation of the RIM-116 Rolling Airframe Missile anti-aircraft system, and a redesigned island. Many of these features were subsequently incorporated in the follow-on Gerald R Ford-class aircraft carriers.

After being formally commissioned into the US Navy in 2003, the ship underwent shakedown training before heading to her new home port at San Diego, via a cruise around South America.

The ship carried out her maiden operational cruise to the Middle East in the first half of 2006. On her return to San Diego, she was designated a surge vessel and was held at readiness for short-notice deployments. In the course of 2007, she took part in surge deployment to the western Pacific region. The ship deployed to the Middle East in 2008 and her aircraft flew 1,150 sorties over Afghanistan to support US and NATO troops in fighting in the central Asian country. A year later the carrier again sailed for the Middle East.

| NIMITZ-CLASS (RONALD REAGAN SUB-CLASS) |
|---|
| **Displacement:** 101,400 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Beam:** 252 feet (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines driving four shafts |
| **Speed:** 30+ kts (56+ km/h; 35+ mph) |
| **Complement:** Ship's company 3,532 and air wing of 2,480 personnel |
| **Armament:** Evolved Sea Sparrow Missile, Rolling Airframe Missile and CIWS |
| **Aircraft carried:** 90 fixed wing and helicopters |

**BELOW: The USS *Ronald Reagan* air group overflies a US-Japanese naval task group during an exercise in the eastern Pacific.** (US NAVY)

After an overhaul in early 2010, the carrier took part in the major RIMPAC exercises with allied nations from around the Pacific. The USS *Ronald Reagan* was heading across the Pacific in April 2011 to take part in an exercise off Korea when a tsunami struck Japan. Pentagon chiefs ordered the carrier to head to Japan at speed to help with the disaster-relief operations. Her helicopters then flew rescue missions along the Japanese coast. As she was off Japan, the ship's radiation detectors picked up contamination from the Fukushima nuclear power plant, which had been damaged by the tidal wave. Seventeen crew were contaminated, and the ship's deck and island had to be decontaminated to remove radioactive particles.

After returning to San Diego, the carrier participated in routine exercises along the US west coast, as well moving home port to Bremerton naval base in Washington state. Then in 2015 the ship was ordered to replace the USS *George Washington* as the forward deployed carrier in Japan. In order to minimise disruption to both ship's crews, a full crew swap took place so the sailors and their families would not have to relocate. The two carriers moored in San Diego naval base and switched crews in August 2015. The USS *Ronald Reagan* set sail for Japan to become the second nuclear-powered aircraft to be based in the country.

This coincided with increasing tension with North Korea over the Asian country's nuclear and rocket programmes. In response, the USS *Ronald Reagan* took part in a series of major exercises with Japanese and South Korean naval forces. The carrier's fighter jets were also scrambled to intercept Russian aircraft that flew close to the ship in 2015 and 2017. As part of the US response to North Korea, San Diego-based Pacific Fleet carriers were routinely deployed to exercise alongside the USS *Ronald Reagan* in Japanese and South Korean waters.

Incoming US President Donald Trump embarked on a policy of confronting Chinese assertiveness in the South China Sea region. To exercise freedom of navigation rights in the South China Sea, the USS *Ronald Reagan* and her battlegroup were dispatched to sail through the disputed region in 2018 and 2020. During the later cruise, the carrier was accompanied by the USS *Nimitz* in a major show of strength.

| CARRIER AIR WING 5 | | | |
|---|---|---|---|
| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
| F/A-18F | 12 | Strike | VFA-102, USN |
| F/A-18E | 12 | Strike | VFA-27, USNF/A-18E |
| F/A-18E | 12 | Strike | VFA-115, USN |
| F/A-18E | 12 | USN | VFA-195, USN |
| EA-18G | 5 | EW/SEAD | VAQ-141, USN |
| E-2D | 4 | AEW | VAW-125, USN |
| MH-60R | 11 | ASW/Strike | HSM-77, USN |
| MH-60S | 8 | utility/CSAR | HSC-12, USN |
| C-2A | 2 | COD | VRC-30 Det 5, USN |

**ABOVE: A homecoming for the USS *Ronald Reagan* after an operational cruise.** (US NAVY)

**LEFT: The USS *Ronald Reagan* underway during flight trials.** (US NAVY)

# USS *George HW Bush* (CVN-77)

## Nuclear-Powered Aircraft Carrier

**RIGHT: The carrier is named after the late President George HW Bush who flew Grumman TBM Avengers in World War Two.** (US NAVY)

The USS *George HW Bush* is the last ship of the Nimitz-class to be built and she is named after the US president who held office between 1989 and 1993. The first President Bush was famously a World War Two naval aviator and he is the second naval aviator to have an aircraft carrier named after him. The first, James Forrestal, had been a naval aviator in World War One and then first secretary of defense between 1947 and 1949. Bush was shot down by Japanese fire after launching from the USS *San Jacinto* but was subsequently rescued by a US submarine. The USS *George HW Bush's* callsign is 'Avenger', in tribute to the TBM Avenger torpedo bombers flown by the former president. The ship is only the second US aircraft carrier to be named after a living former president and he attended the ship's christening ceremony in 2006, which was presided over by his son, President George W Bush.

At a cost of $6.2 million, the USS *George HW Bush* was the most expensive US aircraft carrier built when she was commissioned in 2009. The design of the ship incorporated many changes and improvements.

**BELOW: USS *George HW Bush* under maintenance in dry dock in Norfolk naval base.** (US NAVY)

New features included a bulbous bow design, curved flight deck edges to reduce radar signature, a new underwater hull coating system and a new propeller design. She is the second Nimitz-class carrier to have an enhanced island and a new radar tower, as well as an improved aviation fuel storage and distribution system. She also has a modernised aircraft launch and recovery system, redesigned jet blast deflectors, and improved waste water and electrical systems.

| NIMITZ-CLASS (RONALD REAGAN SUB-CLASS) |
|---|
| **Displacement:** 101,400 long tons |
| **Length:** 1,092 feet (332.8 m) |
| **Waterline:** 1,040 feet (317.0 m) |
| **Beam:** 252 ft (76.8 m) |
| **Draft:** 37 feet (11.3 m) |
| **Propulsion:** Two Westinghouse A4W nuclear reactors, four steam turbines driving shafts |
| **Speed:** 30+ kts (56+ km/h; 35+ mph) |
| **Complement:** Ship's company 3,532 and air wing of 2,480 personnel |
| **Armament:** Evolved Sea Sparrow Missile, Rolling Airframe Missile and CIWS |
| **Aircraft carried:** 90 fixed wing and helicopters |

After work-up training and trials, she sailed for her maiden operational cruise to Europe in 2011. During 2013 she was used for trials of a variety of aircraft and helicopters, including the MV-22B to test its suitability for the carrier on-board delivery role and the MH-53E mine-sweeping helicopters. On May 14, 2013, the ship made naval aviation history when the first ever catapult launch of an unmanned aerial vehicle from a US aircraft carrier occurred. The X-47B air vehicle was then involved in a

**ABOVE: F/A-18F Super Hornets launch from the USS *George HW Bush*.** (US NAVY)

series of touch-and-go trials over the deck of the carrier. The trial period concluded with the first arrested landing by an unmanned aerial vehicle on a carrier on July 10 when an X-47B trapped safely on the USS *George HW Bush*.

The ship was on station in the Arabian Gulf when Islamic State militants launched an offensive against the Kurdish region of Iraq in 2014. On August 8, F/A-18F Hornets from the carrier launched the first US air strikes on Islamic State columns advancing on the Kurdish capital Irbil. This was the start of a prolonged US and coalition air campaign to defeat Islamic State, which was expanded to include attacks on targets in Syria from September 23.

After nine months on duty, the USS *George HW Bush* returned to Norfolk, Virginia in November 2014. The ship returned to the Middle East in early 2017 for another cruise which would see her fly combat missions over Iraq and Syria as part of Operation Inherent Resolve. In July 2017, the ship sailed into British waters to exercise with the Royal Navy's new aircraft carrier, HMS *Queen Elizabeth*. The following year, USS *George HW Bush* hosted French Rafale and E-2D Hawkeye aircraft during a joint exercise off the US east coast.

The USS *George HW Bush* entered dry dock in Norfolk naval base in February 2020 for a 28 month-long maintenance period that would be the first time the ship had been out the water since she was built. The ship left the dry dock in August 2020 to move into the next phase of the maintenance period. No air wing is currently embarked.

**LEFT: The USS *George HW Bush* prepares to sail from Norfolk naval base.** (US NAVY)

# USS *Gerald R Ford* (CVN-78)

## Nuclear-Powered Aircraft Carrier

**BELOW: The USS *Gerald R Ford* is instantly recognisable from its distinctive forward deck shape and unique island layout.** (US NAVY)

The USS *Gerald R Ford* is the world's largest and most expensive warship. She is named for the president who served between 1974 and 1977. Ford had served as a gunnery officer on a World War Two aircraft carrier in the Pacific. He succeeded Richard Nixon after he resigned in disgrace in the wake of the Watergate scandal.

The ship was not formally named after the former president until after his death in December 2006, although the then defense secretary Donald Rumsfeld reportedly confirmed to Ford the decision to name CVN-78 several days before he died.

She is the first new class of aircraft carrier to be built in the US since the late 1960s when the first Nimitz-class ship was ordered. Construction of the carrier began in 2005 and from the start she was intended to incorporate many advanced new technologies with the intention of reducing her crew size by 25% compared to a Nimitz-class vessel and hence reduce her long term running costs. The original contracts for the ship had been worth $7.8 billion but by the time she entered service these had almost doubled because of problems trying to make her advanced technology work effectively.

### GERALD R FORD CLASS

**Displacement:** About 100,000 long tons

**Length:** 1,092 ft (333 m)

**Beam:** 134 ft (41 m) (waterline)

**Height:** nearly 250 ft (76 m)

**Propulsion:** Two A1B nuclear reactors, with four shafts

**Speed:** In excess of 30 kts (56 km/h; 35 mph)

**Complement:** 4539 including air wing personnel

**Armament:** Two RIM-162 ESSM launchers, Two RIM-116 RAM, three Phalanx CIWS, four M2 .50 Cal. (12.7 mm) machine guns

**Aircraft carried:** 75+ aircraft and helicopters

**Aircraft carried:** 90 fixed wing and helicopters

The most revolutionary feature of the USS *Gerald R Ford* is the incorporation for the first time on an aircraft carrier of an electro-magnetic launch system, known as EMALS, to replace the old steam-powered catapult used to launch aircraft from the Nimitz-class ships. The EMALS uses an electric motor to propel aircraft at great speed off the carrier. The old hydraulic arrestor wires to 'trap' aircraft landing on the carrier are replaced with a new advanced arrestor gear system that uses a water turbine.

Some 162 new electrically powered aircraft and cargo lifts are used in the USS *Gerald R Ford* to replace the old hydraulically powered ones. These new technologies remove the need for labour-intensive mechanical machinery so allow the ship's crew to be reduced significantly and allow more rapid aircraft turnaround.

Many of the ship's other major systems are also new, including two

**ABOVE: The USS *Gerald R Ford* is now underway and participating in intensive trials to prove her advanced technology works as advertised.** (US NAVY)

**LEFT: USS *Gerald R Ford* in dry dock during her construction.** (US NAVY)

A1B nuclear reactors, AN/SPY-3 and AN/SPY-4 radars and RIM-162 Evolved Sea Sparrow air defence missiles.

The most obvious difference from the old Nimitz-class ships is the location of the island towards the rear of ship. This allows for a larger parking area for aircraft and helps reduce the ship's radar cross section. All the new design features are meant to contribute to increasing the daily sortie rate to 160, over a month, with a surge capability to rise to 270 sorties a day. This compares to the Nimitz-class routine sortie rate of 120 a day with a surge rate of 240 sorties.

Almost from the start of work on the ship, she had been hit by delays and cost overruns. Her keel was laid in November 2009 and by 2013 the bow and island had been installed but work was starting to run behind schedule so her delivery to the US Navy was put back from 2015 to February 2016. The ship was now projected to be running 22% over budget at $12.8 billion. This soon spiralled to more than $13 billion and the ship was not formally handed over to the US Navy until July 2017. Even then she was not fully functioning, and the US Navy had to be given a special category of service that recognised the ship's status.

The ship was put through a major programme of test and evaluation to prove that her new technology was working as required, with the first F/A-18F Super Hornet landing and launching on the ship on July 28, 2017 to prove the new 'cats and traps' technology worked.

| CARRIER AIR WING 8 | | | |
|---|---|---|---|
| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
| F/A-18E | 12 | Strike | VFA-34, USN |
| F/A-18F | 12 | Strike | VFA-37, USN |
| F/A-18F | 12 | Strike | VFA-97, USN |
| F/A-18F | 12 | Strike | VFA-213, USN |
| EA-6B | 4 | EW/SEAD | VAQ-131, USN |
| E-2C NP | 5 | AEW | VAW-124, USN |
| MH-60R | 11 | ASW/Strike | HSM-70, USN |
| MH-60S | 8 | utility/CSAR | HSC-9, USN |
| C-2A NP | 2 | COD | VRC-40 |

However, in spring 2021 Pentagon inspectors revealed that there were still major problems with the electric lifts and the EMALS, which was registering failures after every 181 launches compared to the required 4,166 launches between failures. These problems led the inspectors to report that the ambitious increase in sortie rates was unlikely to be achieved in the near term.

The ship is scheduled to complete more post-delivery tests and trials in 2021 and 2022 with the aim of being ready for operational deployment by 2024.

**LEFT: Susan Ford, the daughter of the late President Ford inspects the propeller of USS *Gerald R Ford* in 2013.** (US NAVY)

# USS *Wasp* (LHD-1)

## Amphibious Assault Ship

**MAIN PICTURE:** **US Marine Corps MV-22 Osprey tiltrotor aircraft are now deployed on every Wasp-class amphibious warfare vessel.** (US NAVY)

**BELOW RIGHT:** **Giant hovercraft, known as LCACs, routinely operate from the USS *Wasp's* well deck.** (US NAVY)

Work on the USS *Wasp* began in 1985 as part of a major expansion of the US Navy's amphibious capabilities in the final decade of the Cold War. She was finally commissioned in 1989 only a few months before the collapse of the Berlin Wall. The design of the ship, with her large well deck for landing craft and two hangars to support aircraft operations, proved to be ideal for the conflicts and humanitarian crises that unfolded in the 1990s and 2000s. As a result, the US Navy maintained a drum beat of orders for eight Wasp-class vessels through to 2002 when the last ship, USS *Makin Island*, was ordered.

The USS *Wasp* sailed for her maiden operational deployment in 1991 with a marine expeditionary unit embarked. She played an important role in Operation Restore Hope in Somalia in 1993. Over the next decade she was a mainstay of US Atlantic Fleet deployments, including to the Mediterranean and Middle East.

From 2004 the USS *Wasp* was very active supporting US combat operations in Iraq and Afghanistan. In 2007 she carried out the first operational deployment of an MV-22B Osprey squadron. She had previous trialled the Osprey during the early stages of the programme in the 1990s.

During 2011 she was modified to operate the F-35B Lightning and the USS *Wasp* then carried out the first sea trials with the new jump jet to prepare to bring the new aircraft into service. In 2016, AV-8B Harriers and AH-1W Cobras from the USS *Wasp* launched a sustained campaign of air strikes against Islamic State militants besieged in the Libyan city of Sirte.

Two years later the *Wasp* was the first US Navy warship to go to sea on an operational cruise with a detachment of F-35Bs embarked. The ship is currently undergoing maintenance and has no Marine Expeditionary Unit (Special Operations Capable) assigned.

| WASP-CLASS |
| --- |
| **Displacement:** 40,500 long tons |
| **Length:** 843 ft (257 m) |
| **Beam:** 104 ft (31.8 m) |
| **Draft:** 27 ft (8.1 m) |
| **Propulsion:** Two boilers, two geared steam turbines, two shafts |
| **Speed:** 22 kts (41 km/h; 25 mph) |
| **Boats & landing craft carried:** Three Landing Craft Air Cushion or two Landing Craft Utility or 12 Landing Craft Mechanized |
| **Complement:** Ship's company of 66 officers, 1,004 enlisted, with a 1,687 embarked marine contingent, as well as 184 surge capacity. |
| **Armament:** Two RIM-116 Rolling Airframe Missile launchers, two RIM-7 Sea Sparrow missile launchers, three 20 mm Phalanx CIWS systems (LHD 5–8 with two), four 25 mm Mk 38 chain guns and four .50 BMG machine guns |
| **Aircraft carried:** 26 fixed wing aircraft or helicopters |

**The modern-day USS *Essex*, despite being an amphibious warfare vessel boasts far more firepower than her World War Two-era namesake.** (US NAVY)

# USS *Essex* (LHD-2)

## Amphibious Assault Ship

The modern USS *Essex* is the fifth US Navy warship to bear the name and as a flat top takes on many of the traditions of the famous World War Two aircraft carrier which played an important role in the defeat of the Imperial Japanese Navy.

Her first major operation was in 1994 to help cover the withdrawal of US and United Nations peacekeeping troops from Somalia. She was subsequently forward deployed to the Sasebo naval base in Japan in 1999 and operated extensively in the Western Pacific. During the 1990s the ship made operational deployments to the Middle East.

In 2004 USS *Essex* delivered US Marines to Iraq in time for the Battle of Fallujah and was then diverted to assist in humanitarian operations in Indonesia in the wake of the Indian Ocean tsunami that left much of the region devastated. The *Essex* played a similar role in 2011 after another tsunami hit the coast of Japan. The following year she relocated to her home base at San Diego in California.

She was one of the first US warships to be modified with a reinforced flight deck to allow the operation of the F-35B Lightning. The jump jets unique lift fan generated considerably more heat than the old AV-8B Harrier lift nozzles, requiring heat-resistant coatings to be applied to the ship's flat top. In 2018 the *Essex* embarked F-35Bs for a deployment to the Indian Ocean and her F-35Bs launched the first ever combat strikes by the new jet against targets in Afghanistan.

| WASP-CLASS |
|---|
| **Displacement:** 40,500 long tons |
| **Length:** 843 ft (257 m) |
| **Beam:** 104 ft (31.8 m) |
| **Draft:** 27 ft (8.1 m) |
| **Propulsion:** Two boilers, two geared steam turbines, two shafts |
| **Speed:** 22 kts (41 km/h; 25 mph) |
| **Boats & landing craft carried:** Three Landing Craft Air Cushion or two Landing Craft Utility or 12 Landing Craft Mechanized |
| **Complement:** Ship's company of 66 officers, 1,004 enlisted, with a 1,687 embarked marine contingent, as well as 184 surge capacity. |
| **Armament:** Two RIM-116 Rolling Airframe Missile launchers, two RIM-7 Sea Sparrow missile launchers, three 20 mm Phalanx CIWS systems (LHD 5–8 with two), four 25 mm Mk 38 chain guns and four .50 BMG machine guns |
| **Aircraft carried:** 26 fixed wing aircraft or helicopters |

**MARINE EXPEDITIONARY UNIT (SPECIAL OPERATIONS CAPABLE): 13TH MEU(SOC)**
Battalion Landing Team: 3rd Bn/1st Marines

| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
|---|---|---|---|
| F-35B | 6 | Strike | VMA 211 (Rein), USMC |
| AH-1W | 4 | attack | VMM 166 (Rein), USMC |
| UH-1N | 4 | liaison/utility | VMM 166 (Rein), USMC |
| MV-22B | 12 | assault/CSAR | VMM 166 (Rein), USMC |
| KC-130J | 2 | transport | VMM 166 (Rein), USMC |
| SH-60S | 2 | utility | HSC 21 Det, USN |

**F-35B Lightning jump jets are now routinely deployed on the USS *Essex*.** (US NAVY)

# USS *Kearsage* (LHD-3)

## Amphibious Assault Ship

**ABOVE: AV-8B Harrier jump jets from the USS *Kearsage* flew strike missions during the Kosovan and Libyan wars.** (US NAVY)

**BELOW: USS *Kearsage* is currently being prepared to return to fleet service after an overhaul and refit period.** (US NAVY)

The USS *Kearsage* has proved to be one of the Atlantic Fleet's most active amphibious vessels, playing a prominent part in both the Bosnian and Kosovo conflicts in the 1990s and then the 2011 Libyan intervention.

The ship is the fifth US Navy vessel to carry the name and the fourth to serve under its name. The fourth ship was re-named USS *Hornet* after the original USS *Hornet* was sunk in 1942. The original USS *Kearsage* was a Civil War-era sloop.

The current USS *Kearsage's* most high profile mission was during the Bosnian war in June 1995 when helicopters from the ship flew deep into the Balkan country to recover the downed US Air Force F-16 pilot Scott O'Grady. US Marines on two CH-53E Sea Stallions landed inside Serb-controlled territory to rescue the downed pilot, while being protected by AH-1W Cobras and AV-8B Harriers from the USS *Kearsage*. The Hollywood film *Behind Enemy Lines* is loosely based on the rescue mission.

In 1997, the USS *Kearsage* took part in a major non-combatant evacuation operation to rescue 400 American and 3,000 international civilians from the West African country of Sierra Leone after civil war broke out.

Two years later the ship's Harriers were in action over the Balkans again, flying strike missions during the Kosovo war.

In 2005 the ship was docked in the Jordanian port of Aqabba when she came under rocket attack from militants, but the weapons missed, causing no damage to the ship.

In 2011, during the early days of the Libya conflict, the ship's Marines, helicopters, and Harriers were again called upon to rescue two downed USAF airmen after their F-15E Strike Eagle crashed in the North African desert. Harriers flying top cover bombed militia vehicles threatening the rescue operation.

The ship is currently undergoing maintenance and no Marine Expeditionary Unit (Special Operations Capable) is embarked.

| WASP-CLASS |
| --- |
| **Displacement:** 40,500 long tons |
| **Length:** 843 ft (257 m) |
| **Beam:** 104 ft (31.8 m) |
| **Draft:** 27 ft (8.1 m) |
| **Propulsion:** Two boilers, two geared steam turbines, two shafts |
| **Speed:** 22 kts (41 km/h; 25 mph) |
| **Boats & landing craft carried:** Three Landing Craft Air Cushion or two Landing Craft Utility or 12 Landing Craft Mechanized |
| **Complement:** Ship's company of 66 officers, 1,004 enlisted, with a 1,687 embarked marine contingent, as well as 184 surge capacity. |
| **Armament:** Two RIM-116 Rolling Airframe Missile launchers, two RIM-7 Sea Sparrow missile launchers, three 20 mm Phalanx CIWS systems (LHD 5–8 with two), four 25 mm Mk 38 chain guns and four .50 BMG machine guns |
| **Aircraft carried:** 26 fixed wing aircraft or helicopters |

# USS *Boxer* (LHD-4)

## Amphibious Assault Ship

USS *Boxer* is the sixth US Navy vessel to bear the name and traces her traditions to a British frigate, HMS *Boxer*, which was captured by American warships during the war of 1812.

The modern USS *Boxer* was commissioned in 1995 and spent the early years of her service operating in the Western Pacific. Her first major conflict was the 2003 invasion of Iraq when she delivered her Marines to Kuwait to join the advance on Baghdad. Her aircraft then supported ground operations by coalition forces. She then made two more cruises to the Arabian Gulf to support the occupation of Iraq up to 2007.

During her Indian Ocean deployment in 2009, the USS *Boxer* took on an important role in countering pirates based in Somalia, who were preying on international shipping in the region. As the flagship of Combined Task Force 151, the *Boxer* co-ordinated international naval forces countering the pirates. When the US-flagged merchant ship, the MV *Maersk Alabama* was seized by pirates the USS *Boxer* set off in pursuit and acted as the base of operations for an elite team of US Navy SEALs who ultimately rescued the ships master, Captain Richard Phillips. The events were later immortalised in the Tom Hanks film, *Captain Phillips*.

The *Boxer* was again in action in the Horn of Africa region in 2016, supporting US air strikes against Al Qaeda targets in Yemen. Three years later, during a security operation in the Straits of Hormuz, the carrier shot down an Iranian unmanned aerial vehicle.

In June 2020, the ship entered an 18-month major overhaul and upgrade period that will eventually allow the USS *Boxer* to operate the F-35B Lightning jump jet. The ship is currently undergoing maintenance until 2021 and no Marine Expeditionary Unit (Special Operations Capable) is assigned.

### WASP-CLASS

**Displacement:** 40,500 long tons

**Length:** 843 ft (257 m)

**Beam:** 104 ft (31.8 m)

**Draft:** 27 ft (8.1 m)

**Propulsion:** Two boilers, two geared steam turbines, two shafts

**Speed:** 22 kts (41 km/h; 25 mph)

**Boats & landing craft carried:** Three Landing Craft Air Cushion or two Landing Craft Utility or 12 Landing Craft Mechanized

**Complement:** Ship's company of 66 officers, 1,004 enlisted, with a 1,687 embarked marine contingent, as well as 184 surge capacity.

**Armament:** Two RIM-116 Rolling Airframe Missile launchers, two RIM-7 Sea Sparrow missile launchers, three 20 mm Phalanx CIWS systems (LHD 5–8 with two), four 25 mm Mk 38 chain guns and four .50 BMG machine guns

**Aircraft carried:** 26 fixed wing aircraft or helicopters

**ABOVE: An MV-22 Osprey lifts off from the USS *Boxer*.** (US NAVY)

**BELOW: The USS *Boxer* prepares to launch Australian S70 Black Hawk helicopters during a training exercise in the Pacific region.** (US NAVY)

# USS *Bataan* (LHD-5)

## Amphibious Assault Ship

**ABOVE: Sailors and Marines line the deck of the USS *Bataan* as she returns to port after a fleet deployment.** (US NAVY)

The USS *Bataan* is named after the famous World War Two battle in the Philippines and it is the second ship to bear the name.

After being commissioned in 1997, the ship undertook work-up training along the US east coast but had not operationally deployed before the 9/11 attacks on Washington DC and New York in 2001.

In the days after these attacks, she sailed for New York to open her on-board medical facilities to receive civilian casualties. As the US prepared its response to the attack and began preparing to launch an invasion of Afghanistan to defeat the Taliban government shielding Osama bin Laden's Al Qaeda organisation, the USS *Bataan* sailed for the Northern Arabian Sea with the 2,500-strong 26th Marine Expeditionary Unit (Special Operations Capable) (MEU(SOC)) embarked.

The marines from the ship were moved by helicopters into Afghanistan to capture Objective Rhino as a forward operating base for US forces aiming to seize the Taliban stronghold of Kandahar.

USS *Bataan* also sailed to the Middle East in time for the March 2003 invasion of Iraq. After off-loading her marines and their equipment, the ship was re-configured to act as a 'Harrier Carrier' with two squadrons of AV-8B embarked. The jets flew around-the-clock close air support for marines advancing on Baghdad.

After Hurricane Katrina struck New Orleans in 2005, the ship sailed to the city to provide humanitarian relief. Later in the year she acted as the test and evaluation platform for the MV-22B Osprey tilt-rotor and in 2009 the ship hosted the first operational deployment of this new aircraft which was set to revolutionise the USMC's aviation branch.

Subsequent operational deployments included participation in the 2011 Libya operation and USS *Bataan's* Harriers took part in the first air strikes against Islamic State targets in Iraq and Syria in 2014.

**MARINE EXPEDITIONARY UNIT (SPECIAL OPERATIONS CAPABLE): 26TH MEU (SOC)**
Battalion Landing Team: 2nd Battalion/8th Marines

| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
|---|---|---|---|
| AV-8B | 5 | Strike/CAS | VMA 542, USMC |
| AH-1W | 4 | attack | VMM 365 (Rein), USMC |
| UH-1N | 4 | liaison | VMM 365 (Rein), USMC |
| MV-22B | 12 | assault/CSAR | VMM 365 (Rein), USMC |
| KC-130J | 2 | transport | VMM 365 (Rein), USMC |
| SH-60S | 2 | utility | HSC 28 Det, USN |
| MH-60R | 11 | ASW/Strike | HSM-70, USN |
| MH-60S | 8 | utility/CSAR | HSC-9, USN |
| C-2A NP | 2 | COD | VRC-40 |

**WASP-CLASS**

**Displacement:** 40,500 long tons

**Length:** 843 ft (257 m)

**Beam:** 104 ft (31.8 m)

**Draft:** 27 ft (8.1 m)

**Propulsion:** Two boilers, two geared steam turbines, two shafts

**Speed:** 22 kts (41 km/h; 25 mph)

**Boats & landing craft carried:** Three Landing Craft Air Cushion or two Landing Craft Utility or 12 Landing Craft Mechanized

**Complement:** Ship's company of 66 officers, 1,004 enlisted, with a 1,687 embarked marine contingent, as well as 184 surge capacity.

**Armament:** Two RIM-116 Rolling Airframe Missile launchers, two RIM-7 Sea Sparrow missile launchers, three 20 mm Phalanx CIWS systems (LHD 5–8 with two), four 25 mm Mk 38 chain guns and four .50 BMG machine guns

**Aircraft carried:** 26 fixed wing aircraft or helicopters

# USS *Bonhomme Richard* (LHD-6)

## Amphibious Assault Ship

The USS *Bonhomme Richard* is third US Navy warship to bear the iconic name, which traces its origins back the founder of the US Navy, John Paul Jones. The original USS *Bonhomme Richard* played a key role the Battle of Flamborough Head in 1779, with Jones famously refusing to surrender his ship to the Royal Navy, declaring "Sir, I have not yet begun to fight!" This phrase has been adopted as the modern ship's motto. The second USS *Bon Homme Richard* was an Essex-class aircraft carrier which saw service in World War Two, the Korean and Vietnam Wars. She was nicknamed the 'Bonnie Dick'.

| WASP-CLASS |
|---|
| **Displacement:** 40,500 long tons |
| **Length:** 843 ft (257 m) |
| **Beam:** 104 ft (31.8 m) |
| **Draft:** 27 ft (8.1 m) |
| **Propulsion:** Two boilers, two geared steam turbines, two shafts |
| **Speed:** 22 kts (41 km/h; 25 mph) |
| **Boats & landing craft carried:** Three Landing Craft Air Cushion or two Landing Craft Utility or 12 Landing Craft Mechanized |
| **Complement:** Ship's company of 66 officers, 1,004 enlisted, with a 1,687 embarked marine contingent, as well as 184 surge capacity. |
| **Armament:** Two RIM-116 Rolling Airframe Missile launchers, two RIM-7 Sea Sparrow missile launchers, three 20 mm Phalanx CIWS systems (LHD 5–8 with two), four 25 mm Mk 38 chain guns and four .50 BMG machine guns |
| **Aircraft carried:** 26 fixed wing aircraft or helicopters |

The new USS *Bonhomme Richard* made her first operational cruise in 2000 to the Middle East and in December 2001 she sailed again to support Operation Enduring Freedom in Afghanistan. The ship played a leading role in Operation Iraqi Freedom in March and April 2003, acting as a 'Harrier Carrier' with two squadrons of AV-8Bs embarked to provide close air support to US Marines advancing on Baghdad. Her jump jets eventually flew some 547 combat sorties during the brief war.

In December 2004, the ship was ordered to sail to Indonesia to provide humanitarian relief in the wake of the Indian Ocean tsunami which devastated large parts of the island country. Subsequently, the *Bonhomme Richard* and her embarked marines were heavily involved in exercises and diplomatic visits around the Pacific region.

Disaster struck the ship after she was engulfed by a fire during a maintenance period at San Diego naval base. Paint and other flammable materials being used by dockyard workers caught fire. By the time the fire was brought under control five days later the ship was badly damaged, and 61 sailors and dockyard workers had been injured. The US Navy subsequently estimated it would cost more than $3 billion to repair the ship and decided it was not cost effective to bring her back into service. She was due to be decommissioned by the time this publication went to press and some of the salvageable parts will be removed and stored for use in other vessels. No embarked forces are assigned to the ship.

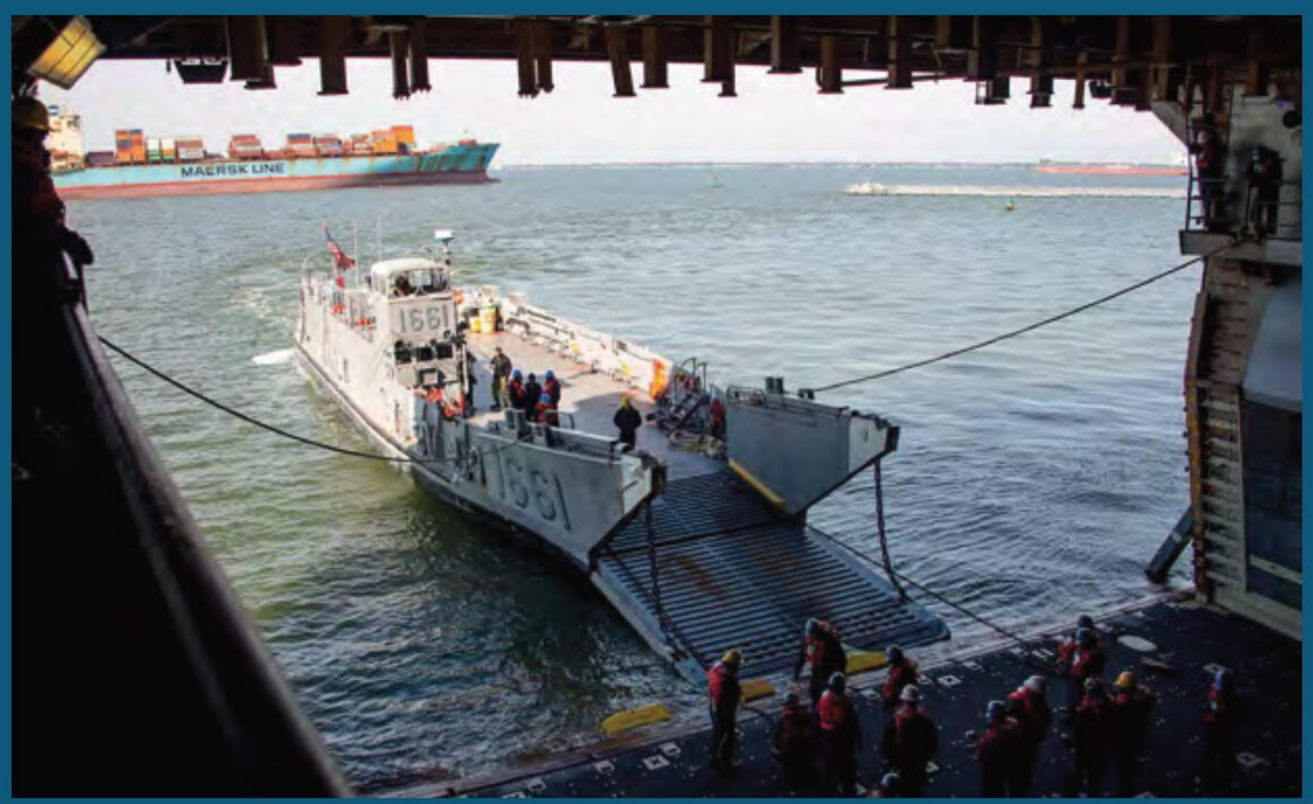
**ABOVE: The USS *Bonhomme Richard* in happier days underway in the western Pacific.** (US NAVY)

**ABOVE: So severe was the fire damage that the USS *Bonhomme Richard* is now to be scrapped.** (US NAVY)

**BELOW: The USS *Bonhomme Richard* burns in San Diego harbour after a fire broke out onboard in July 2020.** (US NAVY)

**RIGHT:** Landing craft operating from her well deck are used to deliver heavy equipment, such as tanks, to shore during amphibious operations. (US NAVY)

**BELOW:** The USS *Iwo Jima* still operates the veteran AV-8B Harrier. (US NAVY)

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| **Aircraft carried:** 26 fixed wing aircraft or helicopters |

The World War Two amphibious assault on the Japanese-held island of Iwo Jiwa has a special place in the history of the US Marines Corps. The modern USS *Iwo Jima's* motto, 'Uncommon Valor', derives from comments made by the US Navy's Pacific commander, Admiral Chester Nimitz, about the sailors and marines who captured the island. "Among the Americans who served on Iwo Jima, uncommon valor was a common virtue," said the admiral.

There have been three ships named USS *Iwo Jima* but the first - a World War Two-era aircraft carrier - was never completed and did not enter service. The second (LPH-2) was an amphibious assault ship decommissioned in 1993 and this third was commissioned in 2001.

Days after the 9/11 attacks on Washington DC and New York, the newly commissioned USS *Iwo Jima* was ordered to New York to provide medical and other assistance to the city authorities.

Her first operational deployment began in March 2003 when she sailed for the Mediterranean carrying the 2,500 strong 26th Marine Expeditionary Unit (Special Operations Capable) (MEU(SOC)). The unit was then flown by helicopter and fixed wing aircraft into northern Iraq to join the advance on Baghdad.

In July 2003, the USS *Iwo Jima* was dispatched to Liberia to provide humanitarian assistance after civil war engulfed the West African country. She was again deployed in the humanitarian role in the wake of Hurricane Katrina after New Orleans was devastated. And a year later the ship and her amphibious group participated in the evacuation of US civilians from Beirut.

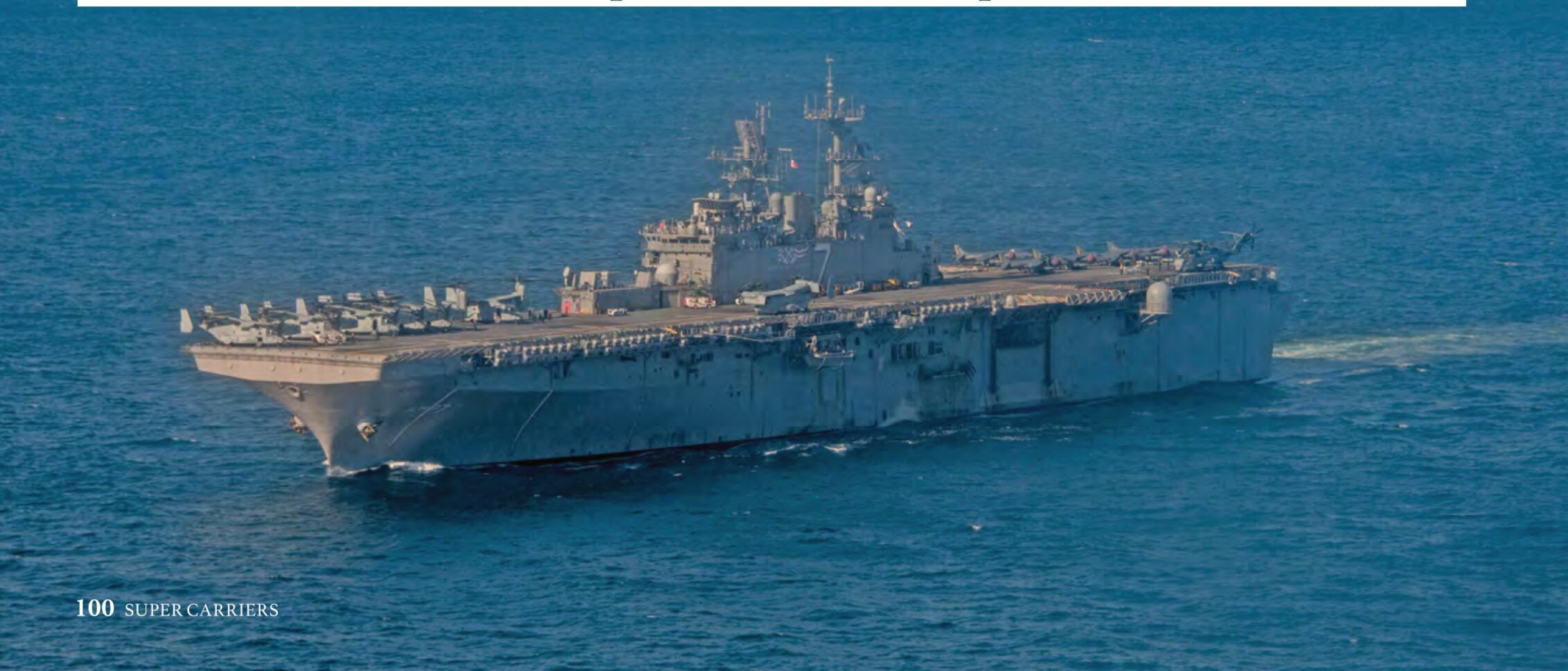
Further cruises to the Middle East took place in 2012 and 2017, responding to crises in Yemen and Israel. The USS *Iwo Jima* played a leading role in NATO's Exercise Trident Juncture in north Norway in 2018, signalling a renewed interest in the region by the US Navy and US Marine Corps.

**MARINE EXPEDITIONARY UNIT (SPECIAL OPERATIONS CAPABLE): 24TH MEU (SOC)**
Battalion Landing Team: 1st Battalion/8th Marines

| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
|---|---|---|---|
| AV-8B | 5 | Strike/CAS | VMA 223 (Rein), USMC |
| MV-22B | 12 | assault/CSAR | VMM 261 (Rein), USMC |
| CH-53E | 6 | Transport Helicopter | VMM 261 (Rein), USMC |
| AH-1W | 4 | Attack helicopter | VMM 261 (Rein), USMC |
| AH-1Y | 4 | Utility helicopter | VMM 261 (Rein), USMC |
| HH-60S | 2 | Utility helicopter | HSC 22 Det, USN |

# USS *Iwo Jima* (LHD-7)

## Amphibious Assault Ship



# USS *Makin Island* (LHD-8)

## Amphibious Assault Ship

**LEFT: A US Marine Corps F-35B Lightning lands on the USS *Makin Island*.** (US NAVY)

The USS *Makin Island* is named in honour of US Marine Corps Raiders who attacked the Japanese held island in August 1942 in one of the first American land offensives of the Pacific campaign. She is the second US Navy ship to bear the name.

USS *Makin Island* has adopted the Chinese phrase 'Gung Ho', or 'to work together', which was the motto given to the newly formed Raiders in 1942 by their first commanding officer, Major Evans Carlson. The Raiders landed by submarine and destroyed the island's Japanese garrison before being successfully evacuated.

The new USS *Makin Island* was the last of the Wasp-class ships and she incorporated many new technologies that were eventually put to use in the follow-on America-class amphibious warfare vessels.

For the first time, a US amphibious warship was powered by a gas turbine and all-electric auxiliary systems. Improved machinery controls, fire-protection systems and command systems were also installed. This new technology allows the engines to be controlled by throttles on the ship's bridge, replacing the traditional engine order telegraphs used on older Wasp-class ships.

The ship was commissioned into the US Navy in June 2009 and then moved port to San Diego, where she subsequently operated as part of the Pacific Fleet. The USS *Makin Island's* captain reported that during the ship's first passage to San Diego around South America more than $2 million had been saved because of the efficiency of her gas turbines.

Her maiden operational deployment to the Middle East took place in 2012 and two years later she played an important role in a US hostage-rescue operation in Yemen. US Navy SEALs launched the mission to rescue a US journalist being held by an Al Qaeda-linked group along with several foreign nationals. The mission met heavy resistance and a number of the hostages, including the American, were wounded and subsequently flown to the *Makin Island* for treatment.

**MARINE EXPEDITIONARY UNIT (SPECIAL OPERATIONS CAPABLE): 15TH MEU (SOC)**
Battalion Landing Team: 1st Battalion/4th Marines

| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
|---|---|---|---|
| F-35B | 6 | Strike | VMFA 122 USMC |
| MV-22B | 12 | Assault/CSAR | VMM 164 (Rein), USMC |
| CH-53E | 4 | Transport Helicopter | HMH 466, USMC |
| AH-1W | 4 | Attack helicopter | VMM 164 (Rein), USMC |
| AH-1Y | 4 | Utility helicopter | VMM 164 (Rein), USMC |
| HH-60S | 2 | Utility helicopter | HSC 23 Det, USN |

**WASP-CLASS**

**Displacement:** 40,500 long tons

**Length:** 843 ft (257 m)

**Beam:** 104 ft (31.8 m)

**Draft:** 27 ft (8.1 m)

**Propulsion:** Hybrid electric propulsion driving two shafts

**Speed:** 28 kts (52 km/h; 32 mph)

**Boats & landing craft carried:** Three Landing Craft Air Cushion or two Landing Craft Utility or 12 Landing Craft Mechanized

**Complement:** Ship's company of 66 officers, 1,004 enlisted, with a 1,687 embarked marine contingent, as well as 184 surge capacity.

**Armament:** Two RIM-116 Rolling Airframe Missile launchers, two RIM-7 Sea Sparrow missile launchers, three 20 mm Phalanx CIWS systems (LHD 5–8 with two), four 25 mm Mk 38 chain guns and four .50 BMG machine guns

**Aircraft carried:** 26 fixed wing aircraft or helicopters

**LEFT: The USS *Makin Island* sets sail from San Diego naval base in 2011 with her full Aviation Combat Element arrayed on deck.** (US NAVY)

# USS *America* (LHA-6)

## Amphibious Assault Ship

**ABOVE:** **A night-time launch for VM-22 Ospreys from the USS *America*.** (US NAVY)

**RIGHT:** **F-35B Lightnings were embarked from the first time the USS *America* went to sea.** (US NAVY)

**MARINE EXPEDITIONARY UNIT (SPECIAL OPERATIONS CAPABLE): 31ST MEU (SOC)**
Battalion Landing Team: 1st Battalion/5th Marines

| AIRCRAFT | NUMBER | ROLE | UNIT/SERVICE |
|---|---|---|---|
| F-35B | 6 | Strike/CAS | VMFA 122, USMC |
| MV-22B | 12 | Assault/CSAR | VMM 262 (Rein), USMC |
| CH-53E | 4 | Transport Helicopter | VMM 262 (Rein), USMC |
| AH-1W | 4 | Attack helicopter | VMM 262 (Rein), USMC |
| AH-1Y | 3 | Utility helicopter | VMM 262 (Rein), USMC |
| HH-60S | 2 | Utility helicopter | HSC 25 Det, USN |

The USS *America* is the first of the America-class of amphibious assault ships that is intended to replace the Wasp-class vessels that had been the core of the US Navy's amphibious forces. She is the fourth ship to bear the name USS *America*.

Known as the 'gator navy' or 'green water navy', the US Navy's amphibious forces are designed to dominate littoral waters close to the coasts of potential opponents or enemy nations.

She cost $2.4 billion to build and incorporated many of the features trialled on the USS *Makin Island*, the last of the Wasp-class, including gas turbines and enhanced electrical systems. The first two ships of the America-class, known as Flight 0 vessels, are intended to use airlift to deliver their marines to shore so do not have a well deck to accommodate landing craft. This allows extra-space for fuel and other aviation support facilities. Potentially, America-class vessels can accommodate 20 F-35B Lightning jump jets but are normally intended to operate a marine expeditionary unit that combines F-35B or AV-8B Harriers, MV-22B Osprey tilt-rotors, CH-35 Sea Stallion heavy lift helicopters, UH-1Y Huey utility helicopters and AH-1W Cobra helicopter gunships. The design of the America-class was modified from the third ship to re-incorporate a well deck and allow the ships to launch and recover landing craft.

USS *America* was formally commissioned into the US Navy in 2014 and embarked on a work-up cruise around South America before heading to her new home port in Japan. She now normally operates in the Western Pacific region with the marines and aircraft of the 31st Marine Expeditionary Unit (Special Operations Capable) embarked.

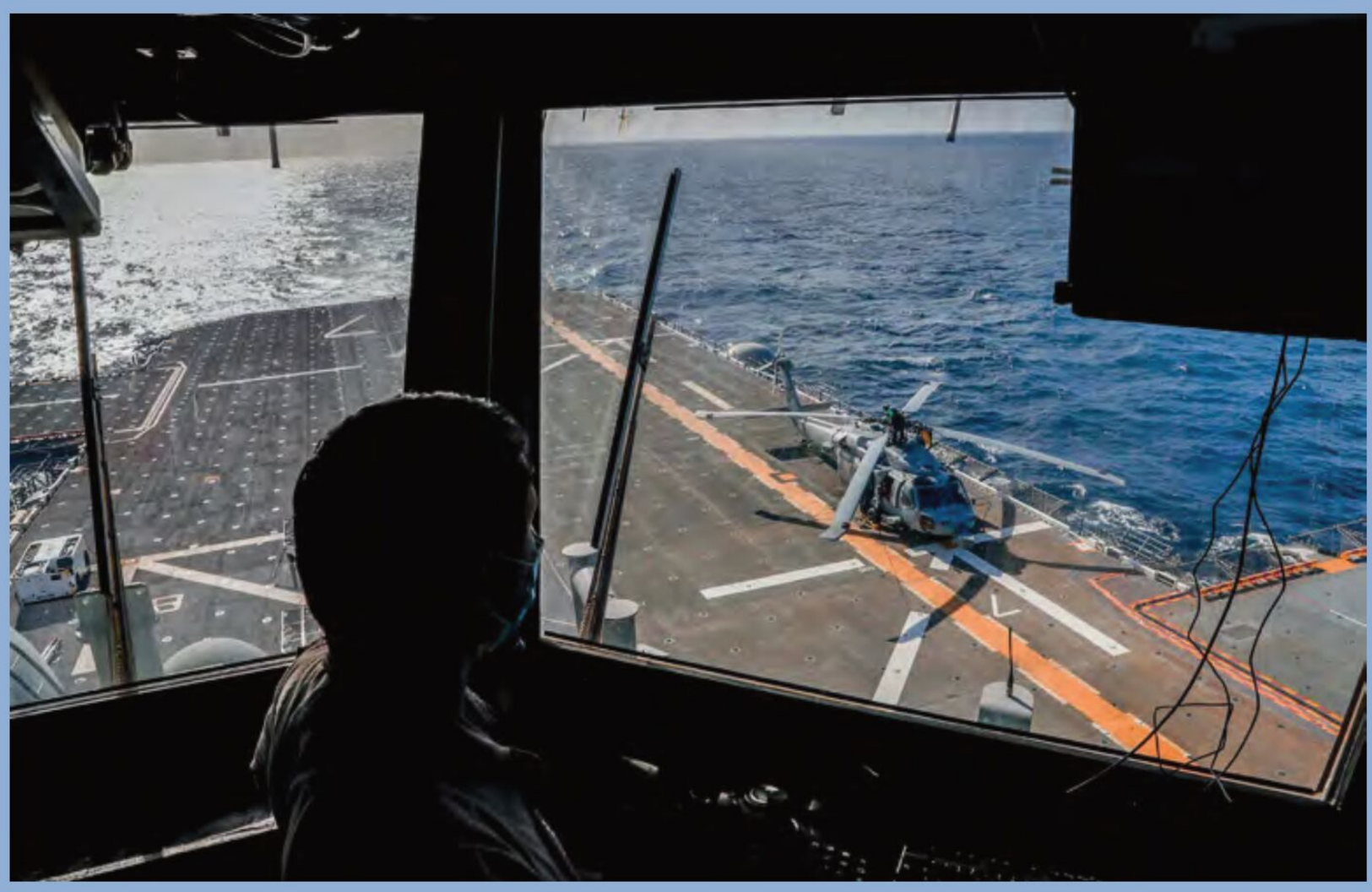
| AMERICA-CLASS |
|---|
| **Displacement:** 44,971 long tons |
| **Length:** 844 ft (257 m) |
| **Beam:** 106 ft (32 m) |
| **Draft:** 26 ft (7.9 m) |
| **Propulsion:** Two gas turbines, two shafts |
| **Speed:** Over 22 kts (41 km/h; 25 mph) |
| **Complement:** Ships company of 65 officers and 994 enlisted sailors, plus 1,687 embarked Marines with a 184 surge capacity |
| **Armament:** Two Rolling Airframe Missile launchers, two Evolved Sea Sparrow Missile launchers, two 20 mm Phalanx CIWS, 2x 25mm M242 Bushmaster Machine Gun System, seven twin 0.50 Cal machine guns |
| **Aircraft carried:** 32 fixed wing aircraft or helicopters carried |

# USS *Tripoli* (LHA-7)

## Amphibious Assault Ship

The USS *Tripoli* is the third US Navy vessel to be named after the first land battle fought on foreign soil by US Marines. The action took place in 1805 during the first Barbary War and is memorialised in *The Marines' Hymn* with the line, "to the shores of Tripoli".

She is the second America-class vessel and is identical in design to the USS *America,* which are known as a Flight 0 vessels. It was proposed that she would be named the USS *Fallujah* after the battle in Iraq in 2003 but in the end, it was decided to adopt the name previously given to a World War Two era escort carrier and the Cold War-era Iwo Jima-class amphibious assault ship.



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| **Aircraft carried:** 32 fixed wing aircraft or helicopters carried |

Like the USS *America* and all the Wasp-class vessels, the USS *Tripoli* was built at Huntington Ingalls Industries shipyard at Pascagoula in Mississippi. This specialist facility is purpose-designed to build amphibious warships.

Work on her got underway in 2013 but after she was launched in 2014 construction soon fell behind schedule. The ship was eventually handed over to the US Navy in February 2020. However, several sailors became infected with the COVID-19 virus and work on the ship fell behind schedule again.

The ship was transferred to her new home port at San Diego navy base in September 2020 in preparation for her commissioning into the US Pacific Fleet. USS *Tripoli* was formally commissioned into US Navy service in July 2020 but by the spring of 2021 she had not yet conducted an operational deployment. It is expected that the ship will make her first deployment in the Western Pacific region with F-35B Lightning II jump jets embarked rather than the older AV-8B Harriers. No Marine Expeditionary Unit (Special Operations Capable) has yet to be assigned.

**ABOVE: A US Navy SH-60 touches down on the USS *Tripoli* in 2020.** (US NAVY)

**BELOW: The USS *Tripoli* underway during trials in 2019.** (US NAVY)

# USS *Bougainville* (LHA-8)

## Amphibious Assault Ship

**ABOVE: An artist's impression of how the USS *Bougainville* will appear once completed.** (US NAVY)

The USS *Bougainville* is named after the famous World War Two island-hopping campaign which saw US Marine Corps units defeat Japanese troops in New Guinea. She is the second US Navy ship to honour the campaign, with the other being a World War Two aircraft carrier.

Unlike the first two ships of the America-class, the USS *Bougainville* is being built with its own well deck to allow the ship to launch and recover landing craft. This new variant is known as Flight 1 and its adoption followed input from senior US Marine Corps officers who were keen to increase the operational flexibility of the America-class ships. The ship also incorporates the new AN/SPY-6 Enterprise Air Surveillance Radar as its main sensor system.

The re-design means that there is a corresponding reduction in hangar space and the ship's medical facilities to allow the well deck to be incorporated. The ship's island has also been modified to allow greater space for maintenance of MV-22 Ospreys parked on deck. The main flight deck is also being reinforced during construction to ensure that she can operate the F-35B as soon as she enters service, unlike the first two vessels of the class which had to be modified to embark the new jet.

Work on the ship began in 2018 and the US Navy expects to take her into service in 2024. The US Navy has already contracted Huntington Ingalls Industries to begin work on the fourth ship of the America-class which will be of the Flight 1 configuration. This fourth ship has yet to be named.

No Marine Expeditionary Unit (Special Operations Capable) has yet been assigned.

**RIGHT: Work starts on the USS *Bougainville* in the Huntington Ingalls Industries shipyard in Mississippi, where all the current generation of US Navy amphibious ships have been built.** (US NAVY)

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| **Aircraft carried:** 32 fixed wing aircraft or helicopters carried |

# Type 003 Aircraft Carrier

## Conventionally Powered Aircraft Carrier

China's third aircraft carrier is currently under construction at the Jiangnan Shipyard in Shanghai and is not expected to enter service for two or three more years at the earliest.

She will be the first Chinese carrier to incorporate a catapult launch system to allow high performance fast jets and fixed wing airborne early warning aircraft to operate from her deck. Work reportedly began in 2015 but few details have been made public, resulting in the more accurate information about her capabilities coming from studying commercial satellite imagery of construction work on the ship. Block modules of the ship's hull started to be moved into a dry dock in May 2020, allowing the shape and size of the ship to determined for the first time.

Senior People's Liberation Army Navy (PLAN) officers say the carrier is to have electro-magnetic catapults, rather than the old-style steam catapults that are currently used in US and French carriers. The US Navy has introduced its own electro-magnetic catapult on its Gerald R Ford-class carriers, but the system has been beset by technical problems.

The new Chinese carrier has yet to be formally named and this is not expected to happen until she is launched.

Satellite imagery of her hull under construction indicates that her flight deck has yet to be put in place. Her length from bow to stern is more than 300 metres, suggesting she could end up similar in size and weight to the old US Navy Kitty Hawk-class carriers that came in at some 325 metres long and more than 61,000 tons. This would indicate that the Type 03 could boast an air group of more than 70 fixed wing aircraft when she puts to sea.

There have been reports that work has begun on a fourth carrier, the Type 04, at the Jiangnan Shipyard and that she will be a nuclear-powered vessel akin to the US Nimitz-class. She could carry up to 100 J-15 and J-31 fighters, Xian KJ-600 airborne early warning and control aircraft and stealth attack drones.

**LEFT: An aerial view of the Type 003 aircraft carrier under construction in Shanghai in November 2019.** (@RUPPRECHTDEINO)

**BELOW: The progress of work on the Type 003 can be easily monitored from commercial satellite imagery. These images date from October 2020.** (MAXAR TECHNOLOGY)

# Future French Aircraft Carriers

## Replacing the FS *Charles de Gaulle*

**RIGHT:** France's new-generation aircraft carrier, or PANG, should be operational by 2038 and is expected to operate a mix of manned and unmanned aircraft. (NAVAL GROUP)

**BELOW:** A carrier capable version of the Franco-G erman Future Air Combat System is being earmarked to operate from France's next generation aircraft carrier. (AIRBUS)

In December 2020, the French President Emmanuel Macron committed to building a new nuclear-powered carrier to replace the FS *Charles de Gaulle* by 2038.

The carrier, provisionally known as the Porte-avions de nouvelle génération (PANG) or new-generation aircraft carrier, is envisaged as being the biggest warship ever built for the French navy. It will be designed from the outset to operate the carrier version of the Franco-German Future Combat Aircraft System (FCAS), which is being developed to replace the Rafale M. Some 30 of the new stealth fighters will be able to be embarked on the carrier, as well as airborne early warning and control aircraft, helicopters, and unmanned aerial vehicles (UAVs).

According to the French Ministry of Defence, the new carrier will be in the 75,000 ton class and some 300 metres long. This is 32,000 tons more than the FS *Charles de Gaulle* and it is intended to be 40 metres longer. US-supplied electromagnetic catapults are to be installed on the carrier so she can operate high performance jet powered combat aircraft. The ship will have two K22 power generators each generating 220 megawatts and it is intended to have a top speed of 27 kts.

Naval Group (formerly DCNS) will be the prime contractor on the project and will be assisted by its major industrial partners Chantiers de l'Atlantique, TechnicAtome and Dassault Aviation. It is expected that she will be built in the Naval Group's Brest shipyard, where the FS *Charles de Gaulle* was constructed.

French plans to build a second aircraft carrier had been under consideration when the FS *Charles de Gaulle* was being built but budget cuts forced them to be put on hold. In the first years of this century, the plans were resurrected in the shape of a proposal to build a conventionally powered vessel, based on the UK's Queen Elizabeth-class carriers, which were developed by the French defence company Thales. Known as the 'Aircraft Carrier 2' or the Porte-Avions 2 (PA2), it was eventually cancelled in 2013, again for budget reasons.

# Future Indian Carriers

## Conventionally Powered Aircraft Carriers

The Indian navy is looking to expand its carrier aviation capability by building two new aircraft carriers over the next two decades. The first, the 45,000 ton INS *Vikrant*, also known as Indigenous Aircraft Carrier 1 (IAC-1), is capable of operating an air group of up to 40 aircraft.

She is the first ever aircraft carrier built in India and has been under construction at the Cochin shipyard in the southern state of Kerala since 2009. The ship is expected to enter service in 2022. Indian companies have designed the ship and most of its major components.

The 262 metres (860 ft) long and 62 metres (203 ft) wide ship is being built with a ski jump and arrestor wires to allow her to operate MiG-29Ks. Additional aircraft are being purchased for the ship and the Indian navy are considering options including the French Rafale M and locally made HAL Tejas, as well as fixed wing airborne early warning aircraft such as the E-2 Hawkeye.

Following on behind the INS *Vikrant,* is the INS *Vishal* or Indigenous Aircraft Carrier 2 (IAC-2), which is proposed as being a 65,000 ton vessel equipped with a catapult launch system. The Indian navy are looking to co-operate with foreign companies to draw on their experience of building super carriers, including Britain's BAE Systems, France's DCNS (now Naval Group) and Russia's Rosoboronexport.

Negotiations have started with the US to supply electro-magnetic catapults for installation in the ship, which will also be built in the Cochin shipyard. This will allow far more capable fast jets, carrying bigger payloads and more fuel, to be operated.

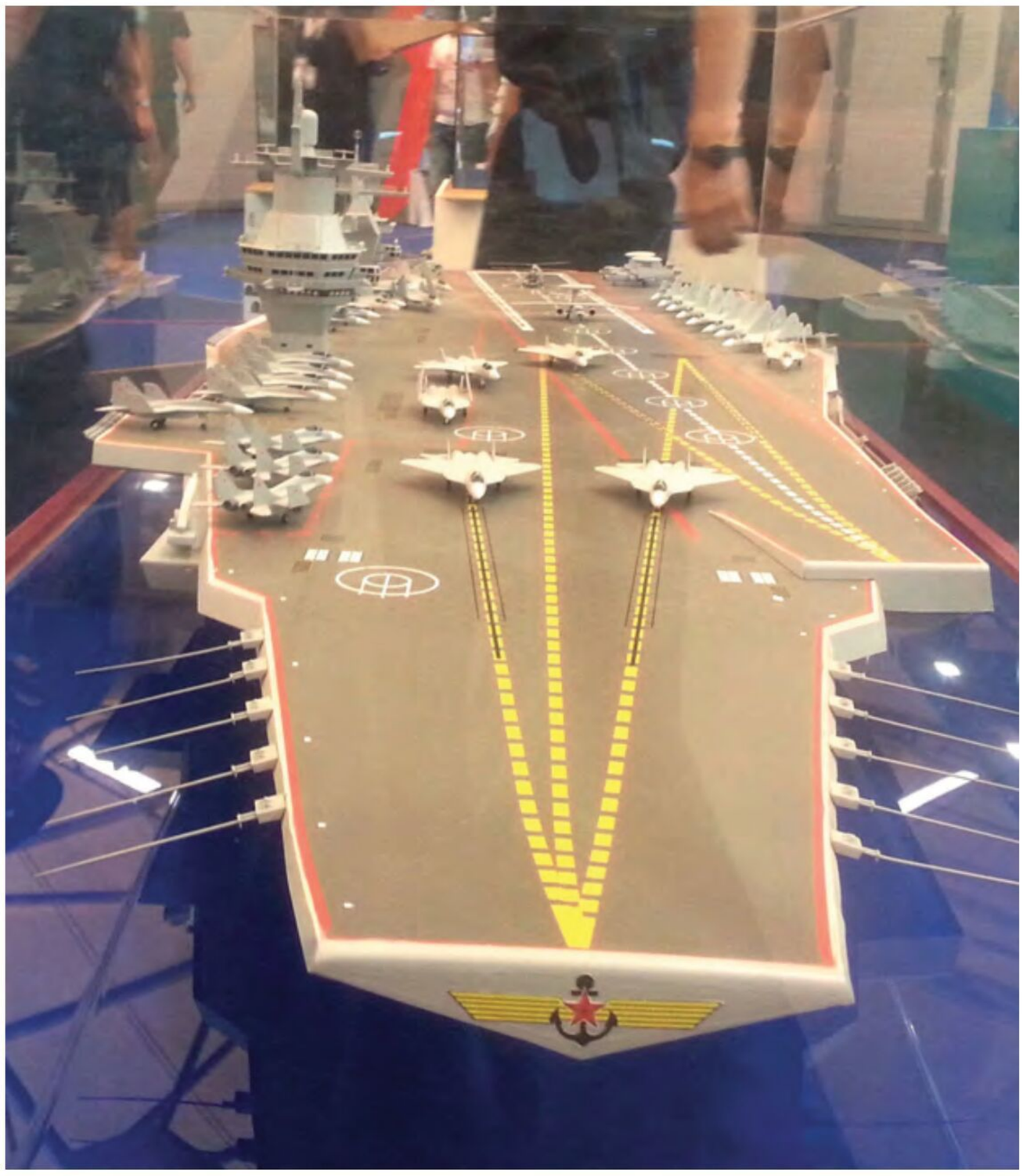
The Indian navy is also investigating operating unmanned aerial vehicles from the carrier, which is envisaged as entering service late in the 2020s or early 2030s. Once the INS *Vikrant* enters service the Indian navy intends to retire the INS *Vikramaditya.*

**ABOVE: India's Indigenous Aircraft Carrier 1, the INS *Vishal*, undergoing basin trials at the Kochi shipyard in Karela.** (INDIAN NAVY)

**BELOW: An artist's impression of the Indigenous Aircraft Carrier 2 (IAC-2).** (INDIAN NAVY)

# Future Russian Carriers

## Keeping Russian Carrier Aviation in Business



**RIGHT: A model of the Project 23000E aircraft carrier concept at the Army 2015 defence exhibition in Moscow.** (RUSSIAN MINISTRY OF DEFENCE)

The foray by the Russian aircraft carrier RFS *Admiral Kuznetsov* into the Mediterranean in 2016-17 showed the importance placed by the Kremlin on the power-projection potential of naval aviation. It put paid to proposals to scrap the carrier and since then there have been persistent reports from the Russian military and defence industry that work is underway on a successor.

In 2017 the *Admiral Kuznetsov* started an extensive refit to allow her to remain in service for another 20 years. Funding for her replacement is expected to be included in the 2024-2033 Russian State Armaments Programme.

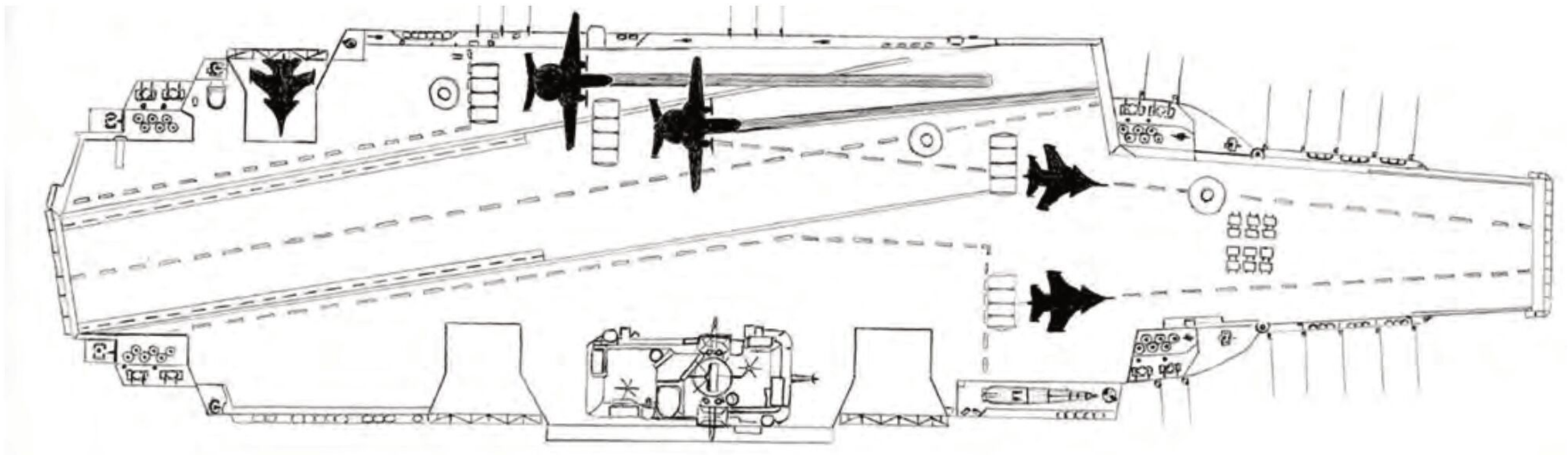
Russian shipbuilding companies have proposed several designs for new aircraft carriers, including nuclear and conventionally powered vessels. It has been the ambition of the Soviet and now the Russian Navy to have nuclear-powered carriers for more than 40 years to compete with the US Navy's Nimitz-class super carriers. In the 1980s work started on the nuclear-powered *Ulyanovsk* but the half-built ship was scrapped after the collapse of the Soviet Union.

A super aircraft carrier design, known as the Project 23000E Storm carrier concept, is also being developed. This 90,000 to 100,000 ton design is optionally nuclear or conventionally powered and has the capability to embark an air wing of up to 100 aircraft. The ship would be protected by the naval version of the new S-500 strategic surface-to-air missiles.

**BELOW: The mother of all Soviet aircraft carriers was the never-finished *Ulyanovsk*, and its influence is still felt today in Russian aircraft carrier ambitions.** (TASS)

The option of having a conventionally powered version is to attract export orders from countries who might not be able to afford to operate nuclear powered carriers. India, or Brazil are considered likely contenders to buy the new ship.

The ability of the Russian shipbuilding industry to actually build such large vessels remains open to question. The Soviet-era carriers were built in the Nikolayev shipyard, which is now in independent Ukraine, and the modern Russian shipbuilding industry has never built a warship of over 40,000 tons.



# America's Future Carriers

## Big Carriers Forever?

Despite increasing concern about the astronomical cost and potential vulnerability of the current generation of monster US Navy aircraft carriers, there appears to be little appetite in Washington DC to stop building more of them.

There are two more carriers of the Gerald R Ford-class under construction and two more are on order. The USS *John F Kennedy* is being fitted out with the intention of replacing the USS *Nimitz* in 2025. Three years later the new USS *Enterprise* is to replace the USS *Dwight D Eisenhower*. Next in line to be replaced is the USS *Carl Vinson* in 2032 and contracts have already been placed to begin work on her successor, the USS *Doris Miller*. The Pentagon is in the early stages of ordering the next Gerald R Ford-class carrier to replace the USS *Theodore Roosevelt*, but it is not clear yet if the new US President Joe Biden will back the idea.

The US Navy has placed early contracts with Huntington Ingalls Industries to begin work on the fourth American-class amphibious warfare ship. The future LHA-9 has not yet been named. Current plans call for eight of the ships to be built to eventually replace all the Wasp-class.

These 46,000 ton ships have also been dubbed 'Lightning Carriers' and the US Navy is looking to use them aggressively in high threat environments, rather than risk moving larger nuclear-powered carriers close to enemy shore lines. During the 2003 Iraq invasion, two Wasp-class ships were re-roled as 'Harrier Carriers', replacing their marines and helicopters with additional AV-8B squadrons dedicated to flying strike missions over the beach. At current prices, LHA-9 is projected as costing $3.8 billion, which is about a third of the price of the Gerald R Ford-class carrier.

**ABOVE: The USS *John F Kennedy* is still being built at the Newport News Shipbuilding yard in Virginia.** (US NAVY)

**LEFT: The future USS *Enterprise* is expected to enter service in 2028.** (US NAVY)

# New Carrier Operators

## Future Carriers around the World

Around the world several navies are looking to field new flat top carriers that have the capability to take fixed wing – both manned and unmanned - airpower to sea. These navies will not be the last to see the potential of operating embarked aviation from the sea.

**ABOVE: The Sedef shipyard in Istanbul is putting the final touches to the amphibious assault ship, the TCG *Anadolu*, which is a derivative of the Spanish Juan Carlos I-class. She is due to go to sea in 2021. It had been intended that F-35B Lightnings would be purchased to operate from the ship, making her Turkey's first ever aircraft carrier, but after the US banned Ankara from buying the jet in response to Turkey buying Russian S-400 missiles, these plans have been dropped. The Turkish military are now planning to operate Bayraktar TB1 armed drones from the ship.** (SEDEF SHIPBUILDING)

**ABOVE: Brazil retired its last aircraft carrier, the *Sao Paulo*, in 2018 and has since been without an embarked fixed wing aviation capability. The Brazilian navy subsequently purchased the former UK helicopter carrier, HMS *Ocean*, and she now serves as the NAM *Atlântico*. The ship is designated a 'multipurpose aircraft carrier' and the Brazilian navy has plans to operate medium altitude, long endurance drones from the ship.** (US NAVY)

**LEFT: South Korea has two Dokdo-class amphibious assault ships which are designed to operate a small detachment of AV-8B Harrier or F-35B Lightning jump jets. In 2017 it emerged that the Seoul government was considering buying F-35Bs to operate from the ships. A new class of vessel, dubbed the LPX-11, is under development to be ready for service between 2030 and 2040. The 40,000 ton ships will be designed from the start to operate up to 20 F-35Bs.** (US NAVY)

**BELOW: The Royal Australian Navy has bought two Juan Carlos I/Canberra- class amphibious assault ships, which have the ability to operate F-35B Lightning jump jets. To date the Australian government has decided not to opt to embark the jets, despite the ships retaining the original ski jumps, on cost grounds.** (NICK D)

# Future Carrier War

## What is the Future of the Aircraft Carrier?

When the first aircraft carriers started to enter service a hundred years ago, few could have imaged the type of missions they would eventually undertake. The rapid pace of technological development in the first half century of the aircraft carrier was unprecedented.

Only 50 years after the first flight off a warship at sea, the US Navy put a 93,000 ton nuclear powered aircraft carrier into service. The next 50 and 100 years of aircraft carrier development looks like they are going to be just as exciting and fast moving.

Before looking at how aircraft carriers and embarked naval aviation could evolve it is necessary to examine the major trends in maritime operations. Some of these would appear to threaten aircraft carriers but many reinforce the need to put airpower afloat.

The dominant trend in naval warfare is the proliferation of highly accurate weapons that could potentially cripple major warships in all corners of the globe. This is combined with the proliferation of data from sensors, such as satellite imagery and unmanned aerial vehicles that can find warships at long range and in all weathers. An increasing number of nations, many which were previously not considered major naval powers, have acquired these sensors and weapons. These dramatically increase the risk of manoeuvring large warships, such as aircraft carriers, within range of these threats.

In this environment, naval forces will have to respond by either fielding their own long range weapon systems and sensors or enhancing their own defences. This game of move and counter-move in naval technology is only accelerating and navies that don't keep ahead of the curve could find themselves on the losing side in any future naval battle.

This has prompted debates in many navies about the way forward. Is it better to have fewer highly capable carriers that can field the best aircraft, in large numbers, to overmatch potential enemies? Or should the risk be spread around a greater number of smaller, if less »

**ABOVE: The future of carrier aviation is expected to involve considerable unmanned elements, such as derivatives of the X-47B Unmanned Combat Air Systems demonstrator.** (US NAVY)

**LEFT: Mini drones launched from small craft could pose a deadly threat to even the largest aircraft carrier.** (US NAVY)

**ABOVE: The first ever launch of an unmanned aerial vehicle from an aircraft carrier's catapult occurred on May 14, 2013 from the USS *George HW Bush* and involved an X-47B Unmanned Combat Air Systems demonstrator.** (US NAVY)

**RIGHT: An X-47B Unmanned Combat Air Systems demonstrator is moved on onto an aircraft elevator aboard the USS *George HW Bush* during 2013 trials.** (US NAVY)

capable, flat tops? By having more ships, a navy could afford to take losses and it is not putting all its eggs on one super carrier-sized basket, or so goes the argument.

So far, the US Navy has not bitten the bullet and opted to stop building more Gerald R Ford class aircraft, taking the view that the size and prestige of having big carriers in situations short of an all-out war with a peer navy, such as the Chinese and Russians, justifies the cost. At the same time, the US Navy continues to build America-class amphibious warfare ships which offer it the potential to mitigate the risk of having to send one of its big flat tops into harm's way. The US Navy is still the only naval service that can afford the luxury of this approach.

Other navies, which lack the financial muscle of the US defence budget, have to hedge their bets, and try to find ways to get more utility out of their limited number of hulls. The UK Royal Navy envisages its new Queen Elizabeth-class carriers being multi-role platforms that can switch between the strike role with F-35Bs jets embarked, amphibious assault role with Royal Marines and transport helicopters embarked, and the littoral strike role with attack helicopters embarked. The ships might have to carry out all three missions simultaneously and would need to have a mix of aircraft and helicopters to do that.

The biggest revolution in aircraft carrier technology is expected to come from the incorporation of unmanned aerial vehicles, or drones. The potential for change is enormous

**RIGHT: The Chinese People's Liberation Army Navy wants to augment its manned J-15 fighters with unmanned combat drones on its future carriers.** (PLAN)

and this has to be seen as more than just a replacement of manned fighter jets with unmanned fighters. It is likely we will see completely new types of air vehicles flying off aircraft carriers, fulfilling new and as yet unimagined missions.

At the moment, carrier air groups usually have separate aircraft to fly specific missions. In the era of unmanned aerial vehicles, there are very different ways to achieve the same effects. Many air arms have projects underway to field swarms of disposable drones. The idea is to make drones that can be tailored for a specific task, such as kinetic attack, electronic jamming, surveillance, communications rebroadcast or airborne early warning. This points to having larger aircraft, either manned or unmanned, that could be launched from an aircraft carrier and in turn launch a swarm of multi-role drones into combat zones. These could either be full-up combat aircraft that would be accompanied by a swarm of unmanned drones, dubbed loyal wingmen, or less capable transport aircraft that just launch drones and are not meant to go into harm's way. This whole unmanned package could have its range and endurance on station dramatically enhanced by the fielding of aerial refuelling drones that pass fuel to the other drones in their formation.

Removing the human element from carrier air operations dramatically reduces the size of crews needed for future aircraft carriers and air groups, as well as reducing their training requirements. For established aircraft carrier navies this would dramatically reduce the cost of operating their ships. The most revolutionary impact on this could be on smaller or less-established navies, allowing them to make a dramatic entry into the carrier aviation business for a fraction of the cost. Swarms of drones can be fielded far more cheaply than fielding a carrier air group of 50 manned aircraft, potentially reducing the cost to affordable levels.

Another route to bring unmanned technology to sea is to embark existing surveillance or armed drones on flat tops. The Turkish navy is, for example, considering putting its combat-proven Bayraktar TB2 on to their new Juan Carlos-class flat top, which is to enter service in 2021. »

**ABOVE: Sailors move an X-47B Unmanned Combat Air Systems demonstrator onto an aircraft elevator aboard the USS *George HW Bush*.** (US NAVY)

**BELOW: An X-47B Unmanned Combat Air Systems demonstrator taxies aboard USS *Harry S Truman* in 2012.** (US NAVY)

**ABOVE: Unconventional naval vessel designs are expected to proliferate and complicate the role of air power in future naval combat.** (US NAVY)

This potentially speeds the fielding of an unmanned capability on the ship but there could be many teething problems when a drone designed to fly from land is put into a maritime environment.

This drive to unmanned naval air groups poses the question about whether flat top aircraft carriers have a future? Could future drone swarms be launched from smaller warships without flight decks or even from submarines - making flat tops redundant?

This of course is a possible future but warships with large flight decks are so inherently flexible that navies will continue to invest in them. Flexibility is a valuable commodity. Flat tops can launch and recover aircraft, embark marines, special forces and attack helicopters or humanitarian aid supplies. Although big flat tops are expensive to build, once in service they are significantly cheaper to modify or upgrade than smaller vessels. New equipment or new types of aircraft can be more easily integrated into large ships than small ships.

Aircraft carriers such as HMS *Queen Elizabeth* or the USS *Gerald R Ford* are designed to still be in service in 50 years but the aircraft that will embark on them after 2040 or 2050 have not been designed or even been thought of yet. By making the ships big, it future-proofs them against whatever developments in naval aviation lie down the road.

Aircraft carriers also have enormous potential to be mother ships for underwater unmanned systems. This will add to their flexibility in a variety of roles.

Naval aviators in the second half of the 21st century may not have as many jets to fly as their counterparts at the turn of the century, but they will still have the same objective – achieving air supremacy over the sea. They will just do it in a different way and with different technology.

## Aircraft Carrier Glossary

**ACE:** Aviation Combat Element (USMC)
**AEW:** Airborne Early Warning
**ASuW:** Anti-Surface Warfare
**ASW:** Anti-Submarine Warfare
**BLT:** Battalion Landing Team (USMC)
**CAG:** Commander Air Group (USN)
**CAW:** Carrier Air Wing (USN)
**COD:** Carrier Onboard Delivery
**CSAR:** Combat Search and Rescue
**CV:** Aircraft Carrier
**CVN:** Aircraft Carrier, Nuclear powered
**CWIS:** Close-in Weapon System
**Det:** Detachment
**FS:** French Ship
**HC:** Helicopter Support Squadron (US Navy)
**HCS:** Helicopter Combat Support Squadron (US Navy)
**HMLA:** Marine Helicopter Attack Squadron, Light (USMC)
**HMH:** Marine Helicopter Squadron, Heavy (USMC)
**HMM:** Marine Helicopter Squadron, Medium (USMC)
**HMAS:** Her Majesty's Australian Ship
**HMS:** Her Majesty's Ship (UK)
**HS:** Helicopter Antisubmarine Squadron
**HSC:** Helicopter Sea Combat Squadron (US Navy)
**HSM:** Helicopter Maritime Strike Squadron (US Navy)
**INAS:** Indian Naval Air Squadron
Indian Naval Ship
**ITS:** Italian Ship
**JMSDF:** Japanese Maritime Self Defense Force
**JS:** Japanese Ship
**LHA:** Landing Helicopter Assault ship
**LPD:** Amphibious Assault Dock ship
**LPH:** Landing Pad Helicopter ship
**MAW:** Marine Air Wing (USMC)
**MEB:** Marine Expeditionary Brigade (MEB)
**MEF:** Marine Expeditionary Force (USMC)
**MEU (SOC ):** Marine Expeditionary Unit (Special Operations Capable) (USMC)
**NATO:** North Atlantic Treaty Organisation
**NAS:** Naval Air Squadron (UK)
**PLAN:** People's Liberation Army Navy (China)
**PLANS:** People's Liberation Army Navy Ship (China)
**RAF:** Royal Air Force (UK)
**Rein:** Reinforced (USMC)
**RFS:** Russian Federation Ship
**SPS:** Spanish Ship
**TLAM:** Tomahawk Land Attack Missile
**UN:** United Nations
**USMC:** US Marine Corps
**USN:** US Navy
**USS:** United States Ship
**VAQ:** Tactical Electronic Warfare Squadron (US Navy)
**VAW:** Carrier Airborne Early Warning Squadron (US Navy)
**VFA:** Strike Fighter Squadron (US Navy)
**VFMA:** Marine Fighter Attack Squadron (USMC)
**VMA:** Marine Attack Squadron (USMC)
**VMM:** Marine Medium Tiltrotor Squadron (USMC)
**VRC:** Fleet Logistics Support Squadron (US Navy)
**VRM:** Fleet Logistics Multi-Mission Squadron (US Navy)

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